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LAND UTILIZATION IN AUSTRALIA

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LAND UTILIZATION IN AUSTRALIA

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PREFACE TO THE FIRST EDITION

THE authors were first asked to undertake the compilation of this book in 1932. After some hesitation they agreed to make the attempt; their deliberation was due, first, to an appreciation of the immensity of the task for a mere handful of people, and, second, to the fact that Australia was then in the throes of an economic crisis which might be expected to have far-reaching effects on rural industries. As the work advanced the transfers of personnel and the difficulties of accumulating the data multiplied the handicaps under which they had to proceed. The slow progress that has been made was due, therefore, to these conditions and to a conviction that a complete re-statement of the problem was imperative, rather than to any lack of interest or enthusiasm in the project.

Australia is as large in area as the United States of America, and this very size acts as a constant depressant of scientific investigation. Popular opinion will persist in the belief that large area means proportionately large resources. On the other hand, the continent is sparsely populated, and its people are, in general, so preoccupied with the tasks in hand that they have no time to be well-informed in regard to either the productive capacity or the unused resources of the continent on which they live. This lack of precise information with respect to factors that are vital to land utilization is very striking; but it is a direct outcome, first, of the failure by the Australian community to set aside an adequate supply of trained research workers, and, secondly, of the long-standing jealousy between Commonwealth and state governments. Under these circumstances, ill-founded opinions on development are persistent and pervasive. Arm-chair theorists with ideas about either 'vast potentialities' or 'dead hearts' are legion. There is a school which believes that, somehow or other, the continent will ultimately support 100,000,000 people. There is another which says that twice the present population will be the optimum density. The number of people who possess a rational valuation of the relative difficulty of the obstacles in the way of land settlement is small. Still fewer are the people who realize that the standard of living at which expansion of settlement is to become possible is the real heart of the problem. Permeating the people of Australia there is a widespread and basic idea that, largely as a result of social and immigration policies, they enjoy a standard of living which should be regarded as sacrosanct. It is, of course, true that, at lower standards of living, both farm and factory industries might expand more rapidly than they do, but who shall blame the Australian for putting life before labour, even if an impartial examination of the living conditions in the marginal areas of Australia shows how illusory this ideal often is. But that this *idée fixe* of an expected standard of living is one of the major factors limiting land settlement remains profoundly true. The economic urge is, in general, more powerful than the 'way of life' impulse in Australia.

With these conditions in mind, the authors proceeded to plan a study on the basis of a preliminary consideration of the various factors stimulating and limiting rural development, followed by an economic survey of each rural industry in turn, and concluding with a discussion of such sociological, political and world economic factors as affect the problem. Unfortunately, these factors, like fractious horses, obstinately refuse to be lined up at the barrier, and as time passes the problem becomes less static and the prediction of the future more difficult.

Despite these drawbacks, a considerable amount of time was devoted to the compilation of data for this study in 1933, and very definite progress was made. Sources of material were prospected, the lodes of information defined, and statistical investigation initiated. At that stage other more urgent pressures had to be given precedence.

In 1934, one author was appointed to a Royal Commission on the Wheat, Flour and Bread Industries. This work involved visiting nearly every wheat-growing district in Australia. This first-hand investigation enabled him to obtain much new information, and afforded abundant opportunity for reflection on the fundamental facts of land utilization in one of the larger rural industries. At that time, the other author visited the United States of America, and made observations on the effect of economic circumstances on the balance of land utilization and on the adjustments of rural industries in another country which is a large producer of primary products. This temporary cessation of direct work on the project brought about certain changes in the attitude of both authors. The first of these was the importance of regarding land utilization as a balance which may be deflected in either direction by economic factors, or by discoveries followed by development of new methods. The additional emphasis of this point of view made it desirable to reconsider the plan of the project so as to treat the subject as an evolutionary sequence, rather than as a review of a completed story. The second was a consequence of the precarious situation of rural industries dependent upon European markets. The contraction of European imports of foodstuffs and raw materials presented an entirely new situation, the implications of which had to be faced as regards changes in the use to which land is put in Australia.

In addition to these considerations, the authors had to keep in mind the fact that the rural settlement of Australia is so new, and the recent advances in technical knowledge of the problems of agriculture have been so considerable that there is at present no certain means of ascertaining the extent to which they will affect rural industries in the future. It would be absurd to pretend that the story of land utilization is in any way complete, or, indeed, more than begun. It is, however, practicable to outline the position as it stands, to hazard a reasonable forecast as to what future developments are likely, and to indicate the factors which will accelerate or retard them.

Assuming this as the general purpose of the book, it seemed logical to develop this survey of a stage in a long-term evolution by a brief description of the previous phases which have led up to it. In this way certain features in the present position, which otherwise might appear anomalous, will be readily understood, in the same way that the vermiform appendix is less of a problem to a comparative anatomist than it would be to a student who had studied only the human body. Further, the historical method of approach affords examples of the way in which invention and scientific work have influenced land utilization in the past, and this in itself gives some sense of the extent to which somewhat similar developments along other lines may influence the matter in the future. Finally, the authors had realized that a book which began with the discussion of the factors governing land utilization was likely to fail on two grounds. Firstly, it would have to be unduly long in its survey of these factors if it were to deal with them adequately from an all-Australian point of view. Secondly, it would run the risk of being very dull to all but enthusiastic experts—and it was felt that the facts of the survey should have a wide appeal.

The structure of the book has, therefore, taken the following form:

(i) A bird's-eye survey, followed by an historical review, drawing attention to the factors which have influenced the successive phases of land utilization in various parts of Australia. Valuable historical surveys of Australian development have been made by several writers (S. H. Roberts, W. K. Hancock, and the late E. O. G. Shann). These authors were, however, not concerned so much with the aspect of land utilization as with the legal or economic features of Australian development. The present authors readily acknowledge much assistance from their works. Without them the historical approach would have been impracticable.

(ii) This historical approach is followed by a study of the natural factors controlling the use of land, in which the various belts of land utilization into which the continent may be roughly divided are considered.

(iii) A series of chapters descriptive of each of the major land industries of the Commonwealth, including some discussion of the factors which tend to move the boundaries of such industries.

(iv) A series of broad conclusions and a brief survey of some economic and international questions bearing upon land utilization.

It will be obvious that a survey of this character has necessitated the presentation of a large amount of factual material. Those readers who are merely interested in the major controls of land utilization, and in the broad conclusions which emerge from this study, might content themselves with the final chapters, fortified by reference to the other sections of the book.

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University of Melbourne
December 1938

PREFACE TO THE SECOND EDITION

THE first edition appeared in 1939 at a time when international relationships were rapidly deteriorating, and although the demand for a reprint was considerable neither author had the leisure to undertake a revision, while a mere reprint would scarcely have been satisfactory. This second edition falls short of its authors' desires, but it has seemed worthy of presentation to fill the current need and to state the position as it exists at the end of the recent war. Although it follows the general lines of its predecessor, many amendments have been made, and some chapters have been virtually re-written, both in order to bring them up-to-date and also to include additional information which has become available.

In the first edition acknowledgment of and thanks for assistance were made to many individuals who were good enough to help with the basic construction. In this edition a footnote expressing appreciation has been inserted wherever an individual has helped with a specific section. Apart from these particular cases the authors are specially indebted to Associate-Professor G. W. Leeper for friendly help and criticism on soil and climatic matters; to the Statisticians of the Commonwealth and the various states for providing statistical material and answering innumerable questions; to Mr. J. A. Aird for advice on the chapter on Irrigation; to Mr. F. M. Read for helpful criticism on sections of the chapter dealing with the Fruit Industries; to Mr. P. S. Lang for comments on the section dealing with the Western District of Victoria; to Professor L. J. Teakle and Mr. R. P. Roberts for information concerning Western Australia; to Messrs. A. F. Bell and W. G. Wells for certain Queensland data; and to Mr. C. J. R. Gorrie for advice concerning animal diseases.

Last, but by no means least, our sincerest thanks are due to Dr. Imre Molnar who has cheerfully carried out an enormous amount of general editorial work, in addition to the preparation of most of the diagrams, and without whose assistance this edition could not have been produced in these busy times.

Many of the plates are new, and in every case the practice of stating the source in the legend has been followed. Grateful acknowledgment is here made of the courtesy of all those individuals and organizations who have granted permission for their reproduction.

This book is an attempt to bring together in one brief volume a large amount of material for the benefit of students and others interested in the rural development of Australia. Since it is not merely a text book, many technical and scientific details could not be discussed. The authors wish to state that the volume is not being produced on a commercial basis.

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December 1947

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LAND UTILIZATION IN AUSTRALIA

Chapter I

INTRODUCTORY

THE utilization of the land in any country at a given moment is a highly complex effect of many causes, and the relative significance of each of those causes can be stated only very broadly. Climate, soil fertility, population pressure, the availability of capital at that particular time, the equipment of the farmer or pastoralist as regards both his implements and his knowledge, and the scope and character of markets for the products of the land are all factors of first importance. But behind this first line of causes there is a long array of secondary factors that cannot be disregarded. The system of land tenure as an aid or a hindrance to differentiation in use, the accessibility of the hinterland from the seaboard, the political attitude of the community towards rural industries, the stage of development reached by secondary industry within the country, and the extent to which capital for land development has been available in the past, are scarcely less significant in their total effect upon the composite pattern of settlement and production.

Even a cursory survey of the extent to which land is used in some of the countries of older civilization provides a salutary warning that population pressure and accessible markets are, by themselves, insufficient to ensure that all land is employed intensively. Even in densely populated Britain there are still large areas where the land is normally only used for light grazing or sport. Such areas, it is true, are mainly found in upland regions, but poverty of soil rather than topography is, in some cases, the determining factor; as, for example, in many of the lowland heaths of the southern and eastern counties which were only brought into use as a result of the extreme necessity for food production at any cost during World War II. On the other hand, examples are not lacking of agricultural developments that have been effected in past centuries which would be quite uneconomic under modern conditions. Thus, in countries where mountain slopes have been terraced and made productive, there is often no record of the vast amount of human labour which past generations have expended on these Herculean tasks. This labour has often been spread over centuries, the driving force being prospective starvation for the individuals or families concerned.

In a way such works represent a capitalization of human sweat; had they been paid for in terms of ordinary wages, they would have been entirely uneconomic, and quite beyond the resources of the community. It is true that in the past some highly developed and commercialized states have organized campaigns to develop such 'marginal' areas in order to achieve self-sufficiency in agricultural products, to develop a rural population, or to decrease unemployment. In a new country, however, unless there is a good

prospect that the settlement achieved will eventually become self-supporting, such uneconomic expenditures on the grand scale are less justifiable, unless labour is available in excess amount and regardless of cost.

The preliminary subdivision of a land utilization survey must start with two main questions: First, 'what proportion of the land is not being used at all?', from which will follow an examination of the reasons why the unused portion has been neglected. The second main question will be, 'how intensively is the occupied portion being used?' A complete examination of these problems would involve an enquiry into (i) those natural factors which prevent the land from being used for those purposes for which it seems at first sight best suited; (ii) the extent to which present forms of land tenure prevent more intensive utilization; (iii) the amount of knowledge available for directing such utilization; and (iv) the psychological reaction of the people towards the land and farming as an occupation.

In a broad way, climate and soil dominate the uses to which land may be put. Within fairly wide limits, however, the relationship of price levels for various products exerts a controlling influence. In Australia, for example, the relatively large margin between the price of wool and its cost of production at certain periods has prevented some areas, otherwise suitable, from being used for cultivation.

The settler in Australia, as in other countries, found an environment that resembled but remotely the conditions of a settled agriculture typical of the European countries from which he came. Through the experience gleaned from much trial and error there emerged an appreciation of certain physical characteristics of the country to which agricultural operations had to be adapted. Profitable farming in Australia was found to depend, to a unique degree, upon reliability of rainfall. Naturally, the distribution of the rainfall throughout the year had a decisive influence upon the type of agriculture which could succeed in any particular district. Further, the soils of some areas possessed peculiar characteristics which had to be learnt, again at the price of much failure. As in many other countries, topography was unfavourable in some districts where rainfall and soil were suitable. The character of the native vegetation presented clearing problems which contributed another stubborn element in a complex which resembled only broadly the structure of old-world farming. This challenge of climate, soil, topography and vegetation called for adaptability and resource, and the development of agricultural techniques suited to conditions unfamiliar to settlers from northern Europe. As settlement spread back from the coast to the hinterland, a certain routine of utilization was developed. The pattern of agricultural resources, in short, was revealed as an inescapable physical control that compelled certain inevitable responses on the part of the settler. How far these responses could be sustained depended on certain other conditions connected with distance from world markets, and with the types of

commodities which could be produced and effectively transported to those markets.

At the stage where the main outlines of the physical problems of the country itself were realized and understood, the economic controls imposed upon land utilization were also taking definite shape. The outlay necessary to bring the land to productive condition fixed a certain standard of expenditure that was the first element in land values. The expenses of working the land, the value of the crop in overseas markets, and the costs of carriage to those markets formed a trilogy that represented the inescapable economic controls to which land utilization was always subject in Australia. Upon the settler's personal efficiency in adapting himself and his methods to the country, and upon the long-term average of prices for his output, depended the surplus which measured the relative success or failure of his particular attempt to utilize the land.

The main feature of pioneering in Australia has been the control of the pace of settlement by the rate at which capital has flowed into the country. Profitability of primary production has been both cause and effect of this influx of capital. Great industrial activity in Europe has provided both the stimulus to land settlement and the source from which capital has been obtained for developing new areas. Thus, high prices for farm products and large imports of capital have usually shown a broad coincidence which explains the boom periods which are such a familiar phase of land settlement. Such booms are, of course, not peculiar to Australia. As W. A. Mackintosh[1] has shown, they have been characteristic of land settlement in Canada and the United States. They are a marked feature of settlement in countries as widely different as New Zealand and the Argentine.

During such boom periods labour and capital pour into the country, and, for a while, great apparent prosperity prevails. The speed and volume of settlement is shown by the opening up of new lands, by closer settlement in the older regions, and by the inflow of migrants. For a longer or shorter period agricultural prices remain high. Then a major fall in prices usually halts settlement, just as the rise in prices touched off the period of expansion. The decline in the profitability of primary production dries up the flow of capital, and a period of stagnation ensues.

The advance of settlement into the marginal lands during the boom, and the halt and retreat during the depression, are now clearly seen to have occurred in all pioneer countries. Such successive waves of settlement are well recognized, and exhibit a broad parallelism everywhere. In short, highly favourable conditions promote enlarged output from the land and a scale of capital investment which cannot be maintained. During these boom periods,

1. Mackintosh, W. A., *Canadian Frontiers of Settlement*, Vol. I (Macmillan): 'It is in the conditions which promote the outflow of the staple product and the inflow of capital that the mainsprings of economic development are to be found.'

over-ambitious policies are put into operation for the 'opening up' of new areas. Roads and railways are laid down, and all the structural framework of pioneer societies provided. Transport becomes the great problem, and public loans for providing transport facilities are common. The provision of communications usually outruns the real needs, and the problem of non-paying railways becomes the most spectacular legacy of boom periods.

Among a commercially-minded people the rate of expansion of rural industry, i.e., the urge to use more land, is dependent on the relative profitability of agriculture as compared with secondary industry. This relative profitability could be demonstrated by showing the margin between the price which the farmer obtains for what he sells and the cost of the things he uses. It is, however, not possible to construct such an index for Australia over the long period. While the profitability of primary industry should properly be measured by contrasting the rise and fall of the export price level with movements in the internal price level, the fluctuations in prosperity are shown with sufficient accuracy by the export price level. If high prices for Australian exports mean a high degree of prosperity for Australia as a whole, as they undoubtedly do, we have isolated one control of living standards. If, in addition, the influx of capital tends to raise the volume of credit and prices, as it undoubtedly does, we have found another control. Taken in conjunction, high export prices plus high rate of borrowing tend to set up conditions promoting a high standard of living relative to other countries, and in this is to be sought the chief urge to expansion of primary industry and the attractiveness of the country for migrants. It is in the operation of these two controls that we have to seek the cause of successive waves of settlement in all countries still in the pioneer stage, and this is confirmed by recent investigations in New Zealand and Canada.

Finally, it must be noted that mere extent of land is far from being an unmixed blessing. Vast stretches of country in Australia, as in North America, must include regions that are uneconomic. Even if they contain potential resources, the problem of transport is an overwhelming factor in the scheme of development. Such countries suffer from geographical elephantiasis. Uneconomic land imposes tremendous costs of carriage through or round the uneconomic area which must be borne by the productive sections. Excessive space, in other words, slows down the tempo of development in a way that is unrealized, for instance, in Great Britain and Europe. It is a source of great weakness to the whole Australian agricultural system merely because of the dead weight of transport costs. Australia, to use a phrase originally applied to the United States, is a vast experiment in transport. Even in areas where land is relatively cheap, the first costs of making the land accessible are too often prohibitive. Under any system of utilization, that particular geographical factor is immutable.

In the early stages of development in any new country, industries to which the land is particularly suited expand, and a system of occupancy which is wasteful as regards area springs up. Such a phase is particularly evident in a country like Australia, where pastoral industries, requiring relatively little organization of communication and transport systems, can thrive. This

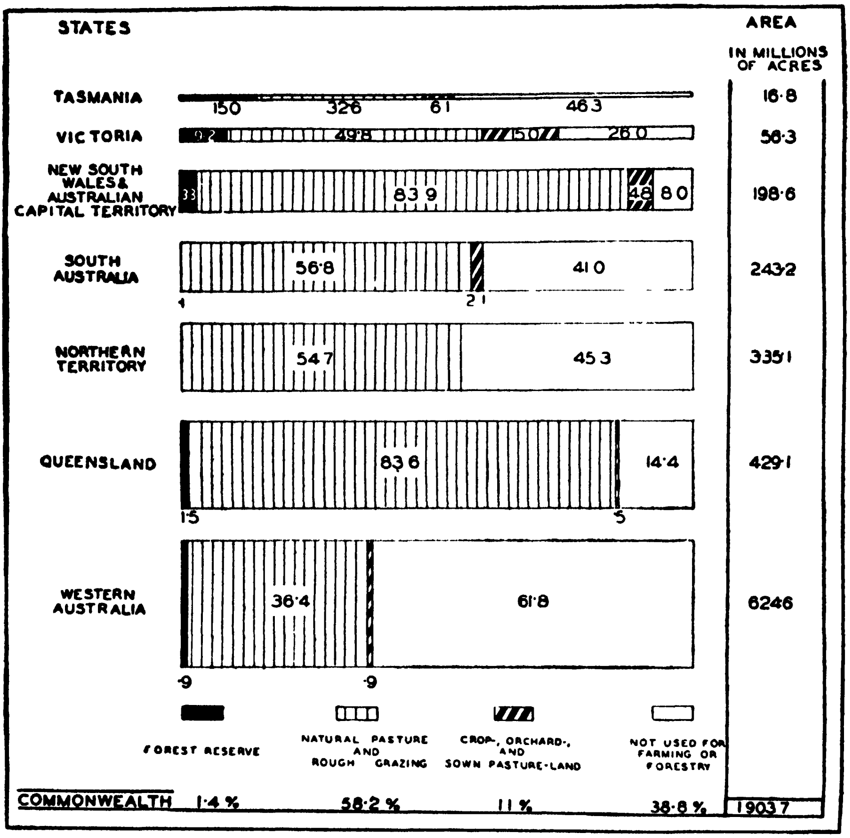


Fig. 1. Land utilization in Australia by states in 1939. Figures in and under the bars indicate percentages

primary occupation of the land gradually gives way to more stable forms of settlement as the initial industries become productive and attract capital for permanent improvements and development. After a more or less stable form of settlement has been achieved, the utilization of the land may still be extensive rather than intensive. The actual degree of intensification will depend to some extent on the energy and initiative of the holders of the land, but equally on their financial resources, although the risks due to climatic

variability and the capacity of the land itself to respond to attempts at improvement must be kept in mind as natural controls.

As time passes, other forms of production become practicable and economic in some districts. Changing conditions in the balance of supply and demand on the world's markets, inventions and scientific discoveries which tend to lower costs of production, and the better adjustment of the technique of farming to the conditions of each district work together to render this development possible. When such circumstances permit of the expansion of a more intensive industry in any area, the earlier form of production is gradually displaced to a lesser or greater degree. Such a transition may, however, be delayed a longer or shorter period if the land is held by conservatively minded devotees of the earlier method of utilization. Economic forces in the long run usually bring about the change, and at times state intervention by taxation or by actual re-possession through purchase may hasten it.

Movements of this kind are not always in the one direction. Those who plan uses for land are not infallible; unexpected difficulties sometimes appear; whole industries suffer declines in the price received for their products, and at times the land reverts once more to its original extensive use. Just as the rural areas of older countries are strewn with the relics of systems of agriculture which have long since passed, so to a lesser extent the countryside of many districts in Australia bears the marks of forms of agricultural production which were developed and flourished for a while, only to be superseded by the present-day method of utilization, which is often that of grazing only.

Figure 1 shows in broad features the way in which land was used in the various states in 1939. It was necessary to present the figure by political divisions because the methods of regarding the data are not quite uniform in the various states. These differences concern the methods of including areas used for roads, lakes, rivers, towns and public purposes. These divergences are of importance only in the categories of 'natural pasture and rough grazing' and 'not used for farming and forestry'; they do not apply to the 'forest reserves' or the 'crop, orchard and sown pasture land.' The diagram throws into high relief the relatively small proportion of the continent which has been brought into intensive use, particularly in the larger states and territories. The incautious observer is at once tempted to draw the conclusion that this low grade of development is in some way connected with the size of the political unit, but, as will be shown in later chapters, the real control has been climatic; the differences between the states in their desire to increase the effectiveness of the way in which the land is used have been negligible.

The extent to which mere occupation has given way to the phase of permanent settlement on a well established basis, and the degree to which settlement is using the land for its most appropriate purpose, and in the most intensive way possible, are a measure of the effectiveness of land utilization.

To some extent there must always be a time lag before occupied land is used to its greatest advantage. The very nature of farming operations, the amount of capital required to change from one form of production to another, and the conservatism of those actually engaged ensure that changes in agricultural methods must be slow. If, however, the problem is approached from the historical angle it should be possible to understand the reasons underlying the emergence of the present agricultural systems, and, further, some attempt may be made to discern whether those systems are unduly archaic in form and lacking in that initiative which determines all progress.

Chapter II

HISTORICAL SURVEY OF SETTLEMENT

1. The First Experiments
2. The Rise and Early Development of the Wool Industry
3. The Development of Wheat-growing
4. The Development of Dairying
5. The Development of Other Rural Industries and Irrigation

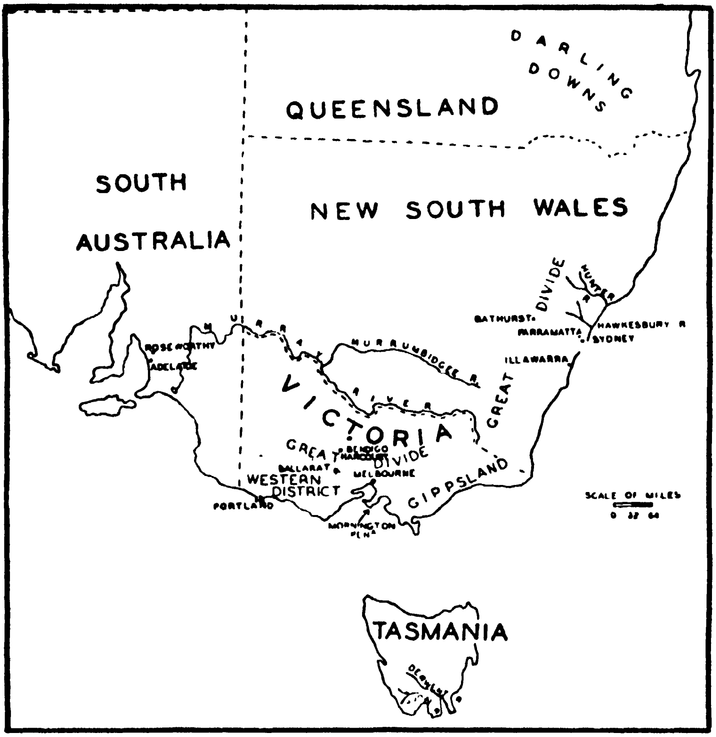


Fig. 2. Key map to geographical names not shown on the figures hereunder and not referred to on maps in following chapters

CHAPTER II

HISTORICAL SURVEY OF SETTLEMENT

THE coastal districts of Australia are, in the main, remarkable for the relative poverty of their soils. Here and there fertile river valleys reach the seaboard, and in some localities soils derived from basalt or other volcanic rocks support a luxuriant vegetation; but for the most part, the leached[1] soils and coastal sands proclaim their poverty both by their appearance and by the vegetation they carry. This poverty was largely responsible for the sparseness of the aboriginal population, and for the emptiness of such large tracts of land comparatively close to over-crowded islands whose peoples were accustomed to making ocean voyages. It may also explain why, although portions of the coastline had been sighted, and occasionally visited, by European explorers, no nation thought the country sufficiently attractive to be worthy of a serious attempt at colonization prior to 1788.

1. THE FIRST EXPERIMENTS

The precarious conditions which attended the beginnings of agriculture were to have considerable effect upon subsequent development. The difficulties encountered and the privations endured were reminiscent of much of the early history of the American colonies, and for many years the resources of the early settlers were taxed to the utmost. Faced by climatic conditions that were unfamiliar, by soils that were chiefly poor in quality, and by clearing problems of a new type, the colonists slowly built up a knowledge of the environment and a technique of land use which was afterwards applied to the better inland districts. Some description of settlement problems selected from typical areas should serve to recall to students of a later day the efforts of an era when lack of knowledge and lack of equipment made pioneering a grim adventure in the wilderness. The following sections represent, therefore, an attempt to throw into relief the trials and errors from which Australian farming practice was gradually and painfully evolved.[2]

As soon as practicable after Governor Phillip landed at Port Jackson he had about nine acres cleared on what is now a portion of the Sydney Botanic Gardens. There, under the direction of a servant named Dod, who had practical experience of farming, the first sowing of wheat in Australia was made. Unfortunately, the result was altogether unsuccessful, for, owing to imperfect clearing, the presence of weevil in the seed, and the destruction of

1. See Chap. III, p. 53.

2. The authors are indebted to a MS. prepared by the late W. S. Campbell, Esq., a former Director of Agriculture for New South Wales and a Fellow of the Royal Australian Historical Society, for considerable assistance in the compilation of this and the following paragraphs dealing with the early days.

the sown wheat by mice and ants, only about a bushel of grain was obtained. Undismayed by this setback, Phillip pushed on exploration, and found more suitable land about fourteen miles to the westward, near where the suburb of Parramatta now stands. Almost all the military officers who arrived with the 'First Fleet' were assigned small tracts of land about Sydney for the purpose of raising grain and vegetables. Experience proved that the soil would produce neither without manure; and, as this was not to be secured, vigour slackened.

Fear of famine prevailed about this time, since most of the seed brought from England or collected at the Cape had become spoiled. However, of 200 acres of cleared land at Rose Hill in the Parramatta area, 55 acres was planted to wheat, and produced 200 bushels, whilst barley was also grown. In 1791, a grant of 30 acres of cleared land was made to a convict farmer as an experiment, in order to ascertain how much land was necessary to maintain a farmer and his family. This experiment being successful, Phillip was instructed by the Home government to afford ex-soldiers facilities to enable them to settle and farm. In 1793 the Surveyor-General made a survey of land in cultivation, and the following facts were recorded:

Wheat	208½	acres
Barley	24½	,,
Maize	1,186½	,,
Gardens	121½	,,
Other cleared land	162½	,,
	1,703½	,,

Yields seem to have been moderately good, over 30 bushels to the acre being harvested in some cases, and in 1796 the total crop of wheat was estimated at about 40,000 bushels, or sufficient for twelve months' consumption. Mills were erected, and the colony was, for the time being, self-supporting in breadstuffs.

The vicissitudes through which the early settlers passed were heart-breaking. In the early part of 1799 the new colonists experienced their first serious drought, and crops were ruined; in midwinter good rain fell, but at the end of the year tropical rains caused floods on the Hawkesbury, and did great damage. By 1801 supplies were again running short, and rations were curtailed.

By 1802 the situation was again under control, but the lessons of the setback were not wasted, and prizes were offered for the best crops. In addition to better yields from the local crops, large supplies of food, including 500 tons of flour and 20 tons of sugar, arrived from England in response to the Governor's somewhat alarming report of the previous year. In 1803, 600 acres of land were under wheat for the government, while nearly 650

acres had been planted by settlers. A creditable yield of 18 bushels per acre was obtained.

The area in which wheat was being cultivated was not really suitable in point of soil or climate, and numerous troubles soon began to appear. These are referred to in a letter from Governor King in 1806:

> Much dependence has ever been placed on wheat as the support of the Colony, and that dependence on the fertility of the soil has been confined to the settlements in and about the Hawkesbury, whereby much of the forest land which is so far from floods has in some measure been neglected. It is not my intention to discourage the growth of that valuable grain, but I do not think it safe for the settlement to rely wholly on wheat for the general support of any class of inhabitants. It is soon destroyed in the fields by the blights, rust, smut, and the caterpillar; also in this climate by fire, and in the stack by weevil; and by corn moths when in the granary, added to which, when the wheat is continually sown on the same land, it impoverishes so much that, if the crop is not destroyed by any of the above common evils, the produce will be small, and by no means equal to the expense of raising it, as the same labour and expense must be used on worn-out lands, that will not produce more than eight bushels of wheat an acre, as upon land that will produce twenty-four.

Difficulties of an economic order were almost as demoralizing to the agriculture in the new colony as the ravages of climate, pests and plagues. The local requirements in grain were relatively small and inelastic; consequently, when once an adequate area had been brought under cultivation, since there were no overseas markets to which surplus grain could be sent, a glut followed a bounteous harvest. On the other hand, two bad crops in succession could easily lead to a dangerous shortage and to dependence upon imports. The price fluctuations consequent on these wide variations in supply were alternatively unsatisfactory to the producers on the one hand, and to the general public on the other; extremes in either direction were a source of anxiety to the authorities.[3] Fears as to scarcity diminished somewhat when Tasmania became an exporter of wheat after 1810. This new factor eased the supply situation, but did not make the cultivation of crops on the coastal plain of New South Wales any easier. Gradually, as other more suitable districts were opened, agriculture in this region became restricted to small localities of specially suitable soil.

The fluctuations in price which characterized the early period of wheat cultivation are typical in the establishment of Australian agriculture, each industry in turn suffering the same disability, until it reached the point when the commodity was being produced on an export basis. As conditions of transport and communication improved, the variations in the local price of any exportable commodity were controlled by the transport costs involved. For example, if in a favourable season a quantity of a commodity were exported, then the local price became the world parity, *less* the cost of transport to, and sale on, the world market; on the other hand, if there

3. See Coghlan, T. A., *Labour and Industry in Australia*, Vol. 1, pp. 142 *et seq.* (O.U.P.).

were a scarcity of supplies of this commodity in the following year, then the local price became the world price, *plus* the cost of transport from the country of supply.

2. THE RISE AND EARLY DEVELOPMENT OF THE WOOL INDUSTRY

Given certain resources, comprising climate, soils and vegetation, the pattern of land utilization will be determined, first, by the possibility of producing export commodities, and, secondly, by the system of land tenure adopted. The first is an inevitable response to the need for permanent equipment in a young country. Imports of capital goods can be paid for only by exports for which a demand exists. There is thus a very rigid control over the type of land utilization which is feasible; for example, the production of tobacco and cotton in the American colonies imposed a pattern of land use which has largely persisted in certain districts. The second factor, the system of land tenure evolved, is largely a result of social and political conditions. Under the conditions which prevailed in the early days of Australia, settlement was a haphazard process of more or less lawful appropriation of land. For anything logical or orderly in the official control of settlement we shall look in vain. There is to be discerned running through the piece, however, a persistent, relentless control which directed, on the one hand, the choice of activities, and, on the other, the conditions under which succcessful production could be carried on. That control was nothing more or less than the natural conditions under which work had to be done, that is, the nature of the country and the climatic conditions.

Fortunately, some of those who were trying to settle in the new country were able to appreciate these factors, and possessed both the will and energy to accelerate the process of mastering the environment. Prominent among them was John Macarthur, who in 1792 realized that

> a petty population, established at so vast a distance from other civilized parts of the globe, could have no prospects of ultimately succeeding unless by raising as an export some raw material which would be produced with little labour, be in considerable demand, and be capable of bearing the expense of a long sea voyage; that, only by the production of some such commodity, whatever might be the natural fertility of the country, could it hope to escape the alternations of abundance and scarcity even of bread.[4]

The commodity which, in his opinion, was most likely to fulfil these requirements was fine wool, and he set about ascertaining whether it could be produced in Australia.

The first sheep had been brought to the new colony by Governor Phillip in 1788. He obtained them from the Cape of Good Hope on the journey out, but as they were intended for meat production, and were either of

4. Onslow, S. Macarthur, *Some Early Records of the Macarthurs of Camden*, p. 57 (Angus and Robertson).

Bengal or Dutch origin, the fleece was far too hairy to be of value to woollen manufacturers. Macarthur himself had a small flock of Indian and Irish sheep, but in 1797 he obtained two Merino rams and four ewes from a number imported from the Cape. He kept these separate from the ordinary flock, and watched their breeding with great care.

Macarthur saw that, if his idea of a fine wool industry was to be realized, it would be necessary to stimulate among the manufacturers of Yorkshire an interest in the possibilities for wool-growing in Australia. Accordingly, he visited England in 1803, and took with him samples of Merino wool from his own flock. He was able to interest the leaders of the woollen industry, and with this encouragement he returned to New South Wales with five rams and one ewe from King George's own flock of Merinos. This experiment in the acclimatization of Merino sheep gave the original impetus to the movement which was to affect so profoundly the uses to which Australian land was to be put. Owing to the great expansion of English woollen manufactures resulting from the application of power to textile machinery, from the large-scale specialization of wool manufacture in Yorkshire, and from the inability of Spain and Saxony to supply the increased demands for raw wool, the English manufacturers were in desperate straits. At that historical moment the demonstration that Australian climatic and economic conditions were favourable to the production of fine Merino wool was a discovery of great textile importance.

In 1807, the first commercial export of fine wool from Australia took place when 245 lbs. were shipped. The prices realized were good; as much as 16s. 4d. per lb. was paid in London for one bale, and as a result the sheep population had reached 25,888 by 1810. 'Woollen manufacturers watching the decline of Spanish and Saxon supplies noted with joy the improving Colonial wools. . . . A Blackwell Hall Factor reported them (1826) more sought after than any other description,' and a London merchant spoke of the cloth they made as 'beyond equal for fineness of texture and softness of quality.' 'Two million pounds of it were said to have arrived that year and sea transport was no longer held a hardship.'[5]

The prices paid for the first wool exports could not be maintained, but although the average weight of wool shorn per sheep was only three pounds, the average profit in 1827 was recorded as 2s. per lb. Due to its high quality and low price, Australian wool rapidly superseded the German product on the English market, and by 1839 our exports amounted to ten million pounds weight. Given careful management, the wool could be grown fairly easily, and these sales demonstrated the possibility of using the land to produce a commodity for which a constant demand existed. At that time only the coastal strip of New South Wales had been occupied, and the carrying capacity of the land was somewhat limited.

5. Shann, E. O. G., *An Economic History of Australia* (C.U.P.).

Up to that time the country lying behind the Great Divide was unexplored. Owing to its dense covering of forest, and its steep and difficult eastern scarps the Great Divide was a formidable obstacle. Once the ranges were crossed, however, the sparsely timbered, well-grassed plains were seen to be eminently suitable for stock-grazing. By 1821 a steady stream of stockmen had crossed the ranges and occupied the Bathurst plains. Extension of settlement to the north of the valley of the Hunter and southwards towards the Murrumbidgee speedily followed.

Van Diemen's Land, as Tasmania was then called, had been occupied in 1803. In 1820, three hundred of Macarthur's Merinos were imported into the island, and the expansion of its sheep industry was rapid. Actually, Tasmania's exports of wool during the next decade often exceeded those of New South Wales, largely because there were in Tasmania greater areas of suitable grazing land adjacent to the harbours.

In 1830, in the areas now known as New South Wales, Victoria and Tasmania, settlers were following hard upon the heels of the early explorers. The problems which land occupation presented to the authorities were, however, very considerable. At first endeavours were made to restrict the area of settlement, but the pastoralists were not deterred by mere fiats of a remote government from spreading outside the specified areas. Without any sort of authority, stockmen travelled out far beyond the limits of the nineteen counties, and most of the specially desirable areas were soon occupied. The administration was powerless to stem the overflowing tide of 'squatters', as they were called.

> A man of small capital acquired a flock and simply set forth. . . . Each man was a land freebooter, scanning the horizon for unoccupied or unclaimed land. He was an overlander, nursing his sore-footed flock, watching every pinch of flour in his bullock-dray of rations, and looking for his plains of promise or his long-dreamed-of mountain pastures. Over the desert and the mountains, over the sun-baked plains and the flooded marsh lands, he went, either seeking some vague landmark dimly hinted at by a previous explorer or one of his rivals, or, more often, trusting to his destiny and his bushman's sense to find virgin country in the general direction in which he was moving. . . . Despite distance and drought, starvation and disease, attacks by the blacks and desertions by his men, he kept on. He was staking everything, often his life, on finding a suitable "run" for his sheep, and until he reached this haven nothing else counted.[6]

By 1836 the coastal settlements of Melbourne and Portland had been founded by settlers from Tasmania, and graziers had crossed the Murray and established themselves in the back country of what is now Victoria. Settlement had also moved northwards, and, by 1840, the boundary of what is now known as Queensland had been crossed, and the first station had been started on the Darling Downs.

Meanwhile, in 1829, the first settlement in Western Australia had been

6. *Cambridge History of the British Empire*, Vol. VII, chapter VII, pp. 191-2.

established on the Swan River, on which Perth now stands. However, the poor nature of the soils of a very large part of this country, owing largely to deficiency in phosphate, and the many problems which arose in connection with stock-raising in some of its regions, made expansion of settlement slow and difficult.[7] The system of allocating land in Western Australia is said to have been far too liberal,[8] but the facts are that the country was not particularly suited for either agricultural or pastoral production under the conditions which obtained at that time.

In 1836, South Australia was established as a 'province' under the Wakefield plan.[9] The whole intention of this scheme of settlement was to foster agriculture; pastoralists were moving inland, and this type of occupation steadily continued to the north and east until 1843.

Some space has been devoted to the history of pastoral settlement, because it focuses attention upon the characteristic difficulties of the country. In particular, the occupation of a considerable area of the better rainfall country in Australia by the process of 'squatting' was a remarkable development. The prime motive underlying it was, of course, the hope of making good profits from producing wool on cheap land. It is impossible to state a figure for the average cost, but, in Victoria, squatters usually paid £1 per acre to the government.

Much has been written about the hazards taken by the early pioneers in the venture, and these risks are undeniable. The entire absence of roads, the sparse facilities for watering, the long distances to be traversed, the necessity for each party to be self-sufficient in regard to food supplies, and the danger from hostile natives, all combined to make settlement an adventurous proceeding.

The first arrivals in any district naturally selected the best areas from the point of view of pastures and water supply. Later arrivals had to content themselves with inferior or less accessible land; and, inasmuch as there was no security of tenure, it was only natural that disputes over individual boundaries were frequent. In the interests of law and order, the government had to set about regaining the control which it had certainly lost. The main difficulty lay in preventing individual occupiers from obtaining portions of the country which were too large, or from retaining areas to which they were not entitled. The only effective card in the hand of the administration was that none of the 'squatters' had any legal right of tenure. Fortunately, there was in the minds of most of the pastoralists a rooted respect and desire for law and order, without which no settler could expect finally to retain the land which he was occupying.[10] Incidentally, also, the government controlled

7. Shann, E. O. G., *Cattle Chosen* (O.U.P.).
8. Roberts, S. H., *History of Australian Land Settlement*, pp. 47, 48 (M.U.P.).
9. Price, A. G., *Foundation and Settlement of South Australia, 1829-1845* (F. W. Preece).
10. As a picture of the conditions which became possible in areas where law and order were not respected, see Lancaster, G. B., *Pageant*, a novel of Tasmania (The Endeavour Press).

all the ports, which were both sources of supply of necessaries of life and also the channels through which the produce of the stations found its way to markets overseas.

Friction between the governments and the 'squatters' lasted, in a more or less acute form, for half a century or more. Some relics of the struggle are still discernible, because, although the resistance of the squatters was eventually broken, there is no doubt that some of the estates which were built up at that time were far too large. As a result, much land which might have been put to better purposes was, and in a few cases still is, devoted to grazing. Another result in the opposite direction has been the creation of a semi-political, anti-pastoralist prejudice in the tradition of Lands Departments in some states. From time to time this has led to unwise subdivision of certain large estates or to attempts to force subdivision by taxation, irrespective of whether the land was suited for smaller-scale farming or not.

It is interesting to speculate what would have happened if the government of that time had been sufficiently powerful to prevent squatting. A more orderly type of occupation would undoubtedly have resulted, but it is questionable whether the progress of settlement would have been so rapid. Under the somewhat disorderly and disconnected type of settlement which occurred, a considerable amount of capital from outside Australia was brought into the country and used in its development; but it is open to doubt whether this investment would have taken place under a more rigid control involving sale of the land in the ordinary way.

It must be emphasized that, at that time, there was no question of any utilization of the land for growing crops for export. The great development of international trade in agricultural commodities which characterized the latter half of the nineteenth century had not yet begun. As yet the main exports on which development had to rely were wool, tallow, sheepskins and hides, and for the production of these materials large areas of country were needed. An important factor was found in the low carrying capacity of much of the country, covered, as it then was, with its more or less dense growth of trees and scrub.

Despite all this, however, the rapid rate at which the pastoral industry had expanded in Australia was not altogether healthy. The very speed of development made the industry vulnerable. It had not been possible, in such a comparatively short period, to master the difficulties connected with climate and the peculiar character of the pasturage. As a result, there was a constant tendency to carry more stock than could be maintained through the difficult seasons. In addition, the tendency observable throughout rural industries in Australia to enter into over-commitments during times of prosperity had been responsible for an uneven rate of progress in the industry of wool-growing. High costs of production and high prices for the product were too often followed by collapse and ruin. This precarious condition of the

balance between returns and costs was, of course, inseparable from the circumstances of the country, but it must be regarded as a background across which passes much of the pageant of Australia's development. One of the earliest instances of this cycle of prosperity is presented by the decade after 1840, during which the world price of wool turned steadily downward. As a result, many properties which had changed hands or been stocked during the boom days of the 'thirties became more and more unprofitable, and pastoralists sustained their first great reverse.

In addition to the precarious nature of the returns, there were recurrent difficulties connected with the supply of labour. No sooner had the industry reached a new, if lower, level of stability than the gold discoveries after 1850 dynamically changed the whole situation. So potent was the attraction of

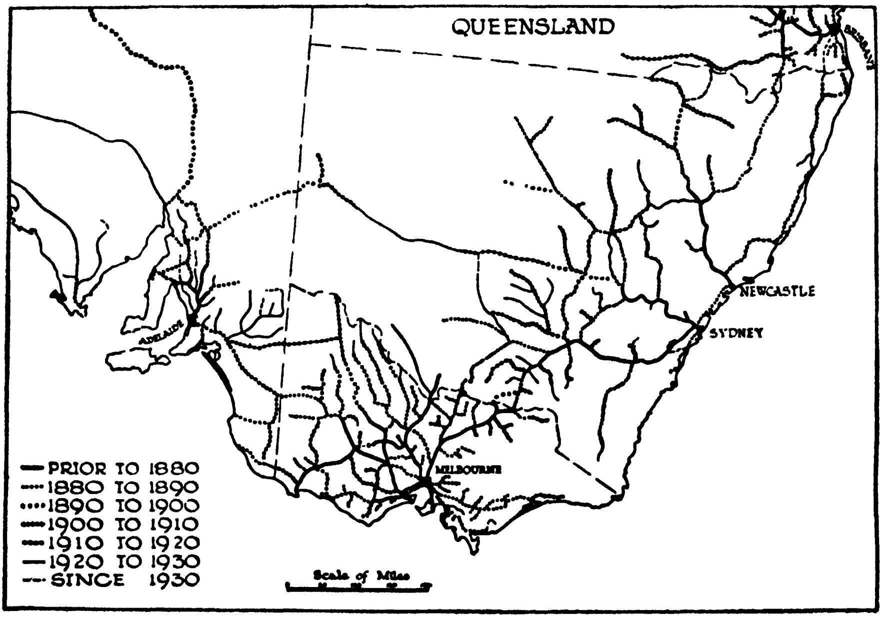


Fig. 3. Railway Development in south-eastern Australia

gold that a total population of less than 200,000 in 1840 had risen to 1,146,000 by 1860. While the first effect of the gold rush was to drain labour from every other primary industry, it was not long before the agricultural industries received an unprecedented fillip, on the one hand from increased labour, and, on the other, from larger home markets. Wool-growing, however, was prejudiced by a great increase in the cost of labour. Indeed, the economic structures of all export industries were adversely affected. Wool, in particular, suffered, as it was to suffer again and again at later stages, from the fact that there existed a very small domestic demand, and

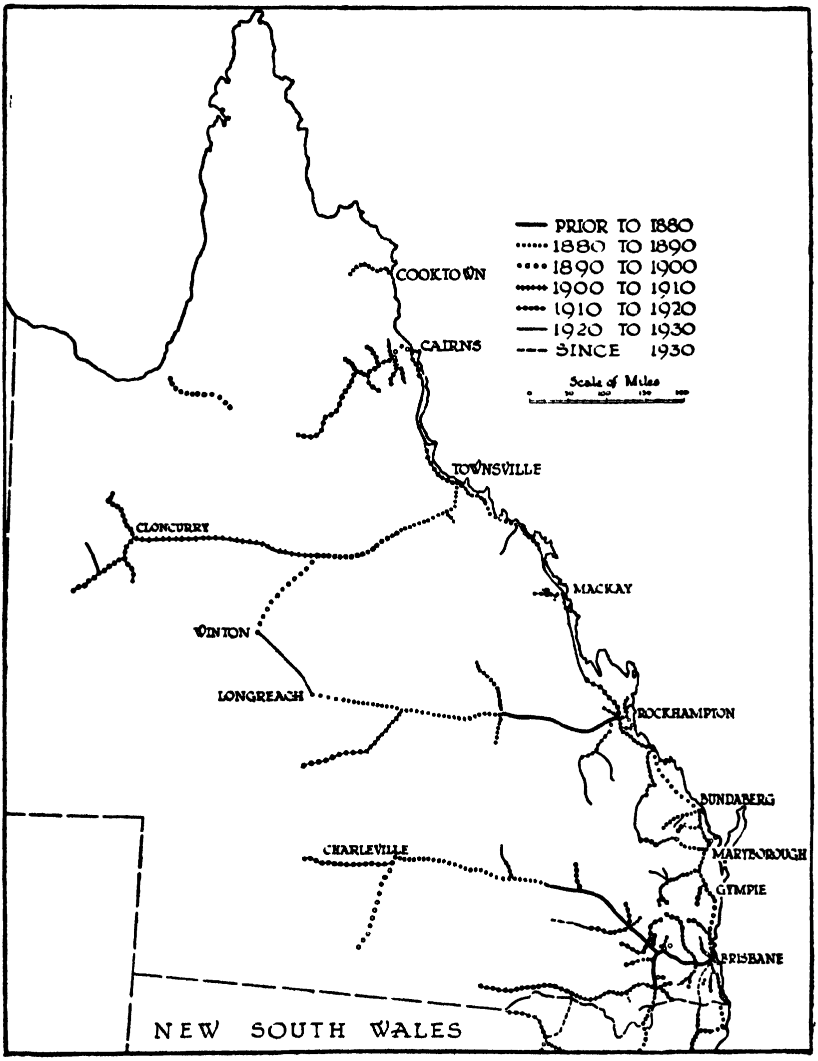


Fig. 4. Railway Development in Queensland

the export was entirely dependent upon world markets. This disparity between home costs and world prices was a difficulty with which Australian primary producers were to become uncomfortably familiar in later years.

A third development stimulated by the gold discoveries was the extension of railways into the inland areas. In Victoria the ranges had been crossed to both Ballarat and Bendigo by 1865; the gateway into what was eventually to prove to be some of the best agricultural land in the state had thus been reached. Similarly in other states, mineral discoveries were the forerunners

of agricultural development, since the population and capital which they brought in their wake accelerated the development of communications. This transport factor, although not of immediate importance, helped to prepare the stage for the next forward move in many districts.

South Australia, however, was in a somewhat different condition during this period, because she had a large area of good agricultural land of the red-brown earth type (Fig. 25)—the Adelaide Plains—adjacent to the main port of shipment. As a result, this province was able to develop a considerable wheat-growing industry, based on the markets of Victoria and New South Wales, which were not at that time self-supporting.

This picture of an opportunist system of land utilization is, however, too simple. Complicating factors were being encountered at every stage. Throughout the period communications were improving, clearing was taking place, and, as a result, the number of sheep increased, although spasmodically. On the other hand, with the increase in the number of people scattered through the countryside, bush fires became far more prevalent, while the removal of the forest cover gradually increased the frequency and severity of floods. The expansion of the pastoral industry was, of course, in the direction of the unoccupied interior or towards the north. Wherever the terrain was too rugged, as in the mountain areas, or the vegetation too dense for sheep, as in Mallee country (Fig. 25), the progress of settlement was slow and cattle were mainly kept. Much of the new country, moreover, was characterized by relatively low rainfall, and prolonged droughts occurred with distressing frequency.

3. THE DEVELOPMENT OF WHEAT-GROWING

The repeal of the Corn Laws in Great Britain had opened the door to the import of surplus wheat from other countries. Until this had happened, it was possible for Australia to export wheat or flour to only a few countries. From now onwards it was practicable for her to export to Great Britain, which became the greatest market for wheat in the world. This development was of the utmost significance, because it removed one of the factors restricting the expansion of wheat production. Other developments were also necessary, however, before the Australian wheat industry could be effectively established on a basis sufficiently stable to meet world competition.

Until the railways had crossed the ranges, most of the farming was conducted on the coastal leached soils (see soil map, Fig. 25), where wheat-growing could only be pursued profitably in rotation with other forms of agriculture, which tended to maintain the fertility of the soil. On these coastal areas the climate and the soil were such as to make wheat-farming unprofitable unless the price received was at least 5s. per bushel.[11] Under

11. See statement by Kenyon, A. S., in *Fourth Report of the Royal Commission on Wheat, Flour and Bread Industries, 1934-36* (Govt. Printer, Canberra).

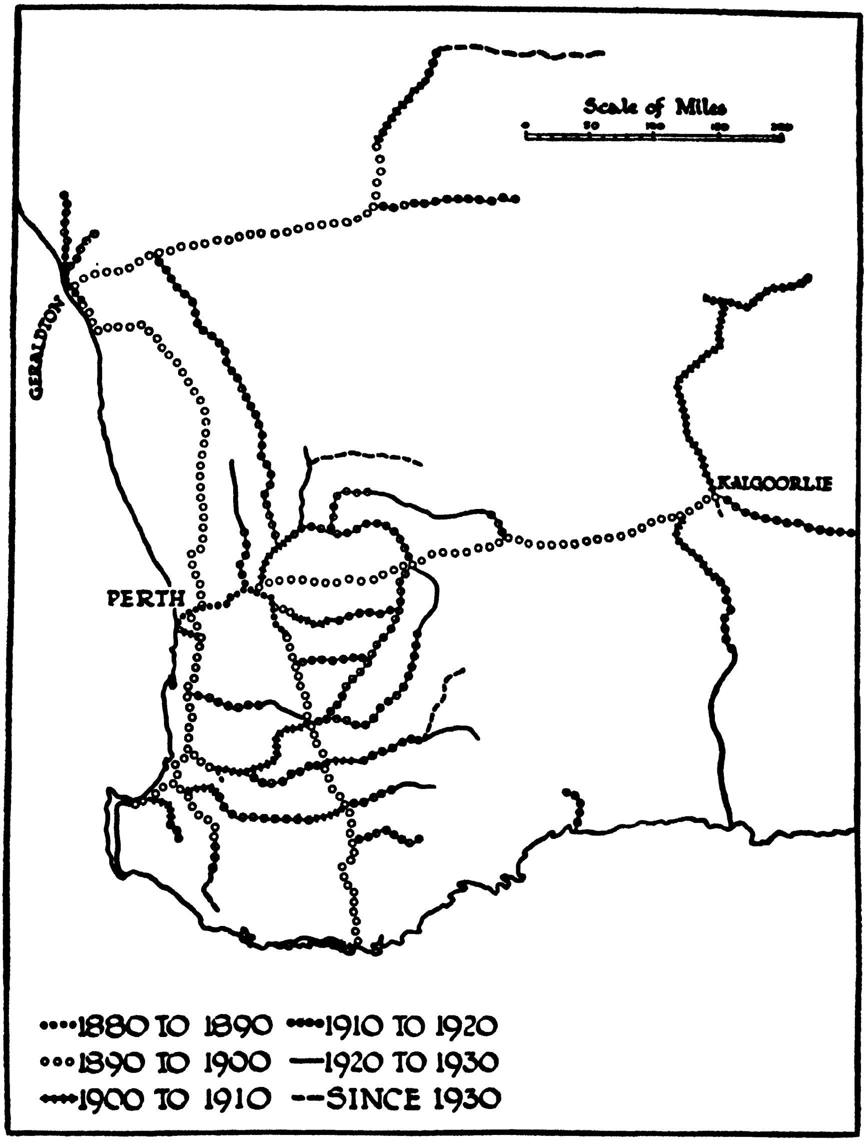


Fig. 5. Railway Development in Western Australia

these circumstances, as long as transport was expensive it was possible for a number of farmers to grow wheat only in response to local demand.

So, it is not surprising that South Australia, with areas of the soils known as 'red-brown earths' close to the ports, was able to develop faster than the other states. When once the railway systems crossed the ranges, however,

they were in contact with districts having new soil types, some of which would permit frequent wheat cropping without immediate loss of fertility. These soil areas usually either carried forest or consisted of types which are known locally as 'crab holes' or 'puff banks'. In areas of the latter kind, the whole countryside may be thrown into a series of pits or troughs, each of which is two or three feet below the adjacent banks. The soil in the pit is different from that of the bank, and, as a result, all cropping is very uneven until the cultivations of a number of years have gradually reduced the whole surface to a common level. Most of the soils of the country are deficient in phosphate, which means that, until a relatively concentrated and comparatively cheap form of artificial manure was available, yields were likely to fall away after the first year or two.

The mechanical aspect of this kind of farming was also very important. In the more primitive types of husbandry, where reaping was carried out either by hand or by the mowing machine, the density of the crop was a factor of great significance. The lighter the yield, the greater was the surface the farmer had to work over in order to harvest a bushel of grain. This meant that, when crops were about ten or fifteen bushels to the acre, a great deal of time was wasted. The advent of harvesting machinery (Plates 16, 17), therefore, meant a great deal more to the farmers growing light crops than to those on fertile soils.

Special machinery was also required to deal with the roots and stumps of the original vegetation (Plates 2, 3). On many of the red-brown earths (Fig. 25) the tree growth was fairly dense; and, although this could be cut and burnt, the difficulty of grubbing the roots was very considerable. On the Mallee soils, which are described on p. 55, the scrubby trees, though individually small, formed such a dense growth that in many cases it was impracticable to remove them by any ordinary means.

Finally, the rainfall of many of these regions over the ranges was less than twenty inches per annum. In most districts it showed a definite tendency to be deficient after September or October, while December usually brought with it high temperatures and very low humidity—conditions which are hostile to the maintenance of a green growth. Consequently, varieties which did not come to harvest before December were incapable of producing a satisfactory crop in most seasons. It was, therefore, necessary to find or to breed new varieties which would fit in with these particular climatic conditions.

During the period 1870-1900 these obstacles were gradually overcome. Railway systems steadily penetrated the wheat areas. Reference to Figs. 3 and 5 will illustrate this development clearly. Secondly, artificial fertilizers came into use. Superphosphate was first used extensively by Professors Lowry and Custance, at Roseworthy College in South Australia in 1882, and its use gradually spread throughout the wheat-growing districts of South Australia and Victoria, and later into New South Wales and Western Australia.

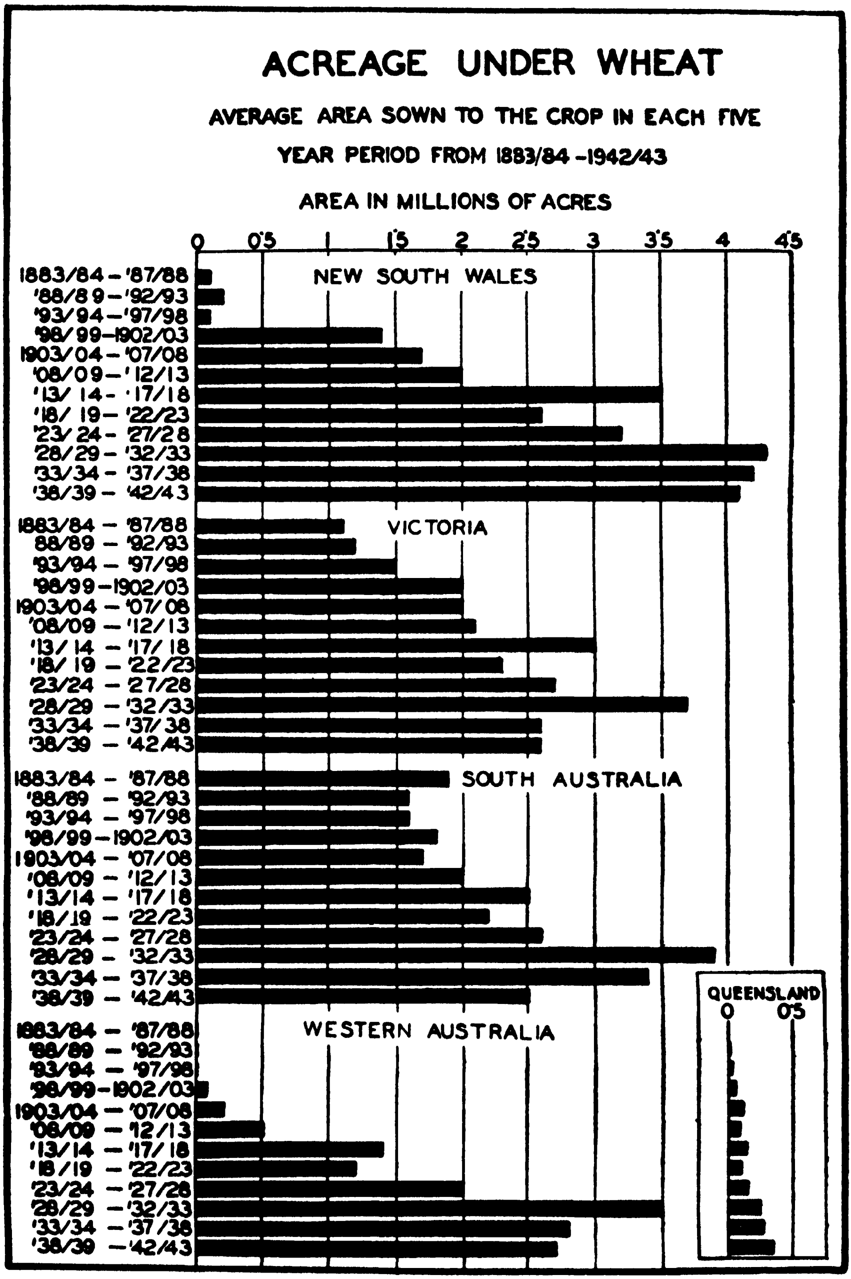

ACREAGE UNDER WHEAT
AVERAGE AREA SOWN TO THE CROP IN EACH FIVE YEAR PERIOD FROM 1883/84 - 1942/43
AREA IN MILLIONS OF ACRES
0 0·5 1 1·5 2 2·5 3 3·5 4 4·5
NEW SOUTH WALES
VICTORIA
SOUTH AUSTRALIA
WESTERN AUSTRALIA
QUEENSLAND
0 0·5
1883/84 – '87/88
'88/89 – '92/93
'93/94 – '97/98
'98/99 – 1902/03
1903/04 – '07/08
'08/09 – '12/13
'13/14 – '17/18
'18/19 – '22/23
'23/24 – '27/28
'28/29 – '32/33
'33/34 – '37/38
'38/39 – '42/43

Fig. 6

Stump-jump implements were first used in South Australia about 1876. The wheat stripper had been invented about 1843, and its use had spread among wheat farmers in South Australia and Victoria. Considerable improvements were effected in these machines during the last two decades of the century. An instrument known as a 'mullinizer' was developed for use on scrub country, and shortly afterwards rollers were used for dealing with the Mallee. Finally, the genius of William Farrer was at work in New South Wales, producing wheats which were suitable for the special climatic conditions. All these improvements in technique gradually came into the hands of the new generation of farmers who were looking for land to develop, now that the alluvial diggings had petered out, and the combined effect was to accelerate the development of the wheat industry. The way in which the area under the crop changed in the various states is shown in Fig. 6.

4. THE DEVELOPMENT OF DAIRYING

Cattle, whether raised for meat or dairy purposes, require a much longer growth of herbage than is necessary for sheep. This fact necessarily implies that these animals are most effectively kept where there is a long rainy period and fertile soil. In Australia these conditions were always conducive to a dense natural forest, which was difficult, and correspondingly expensive, to clear. It followed that, during the early days, settlers were seldom prepared to clear this country, except when it was situated reasonably close to the cities, with their assured markets. As is usual in settlement under these conditions, the area which was cleared, and put to dairying purposes, was considerably in excess of the local requirements during the wet months when pasturage was abundant. The natural economic result was a wide fluctuation in the prices received for products; during the spring butter might bring as low as 4d. per lb. on the farms, while during periods of scarcity it might rise to 2s. 6d. There was no means of maintaining an effective export trade, because the conditions of making the product on the farm were such that it was uneven in quality, and, further, it could only be kept for a short period unless packed in salt. However, even under these conditions, settlement in the forest areas proceeded steadily. As early as 1820 a beginning was made in the Illawarra district, about fifty miles south of Sydney, while further north dairying was spreading in the Hunter and other valleys. In Victoria, some of the best lands in the Western District were also developed on a dairying basis, and in the period 1875-1890 the rich country of the western Strzelecki ranges was also pioneered in this way.

This Strzelecki region of Western Gippsland (Fig. 7) is of particular interest, because settlement began there on the eve of the important discoveries which were to make it practicable for the dairying industry to expand rapidly. The memoirs of many of the earlier settlers in this area have been collected, and the following account is descriptive of the conditions under which the

land was developed.[12] The district was largely covered by a very dense forest of Eucalypts, the average height of which was about 150 feet. Undergrowth was very dense, and the trees were bound together with trailing plants, which made it almost impassable. Count Strzelecki, the first explorer to pass through the region, took twenty-two days in 1840 to cover fifty miles, and, at the end of the journey, he and his companions were on the verge of starvation and their clothing in shreds.

Settlement began at the west end of the range about 1870-75, the township of Poowong becoming the centre. At that time there were no

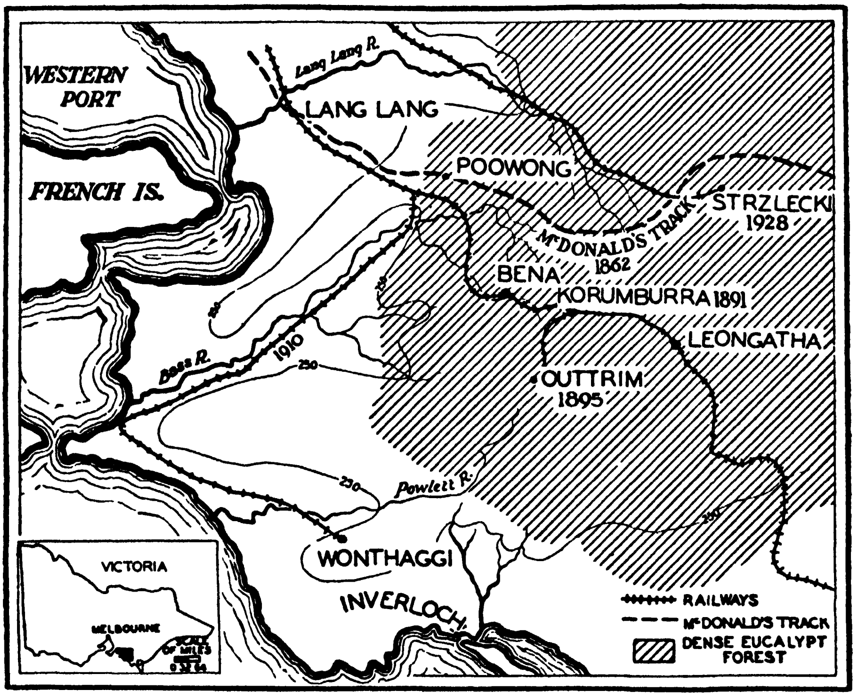


Fig. 7. Western Gippsland, Victoria

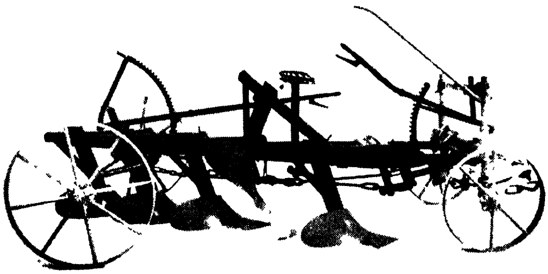
The map shows the location of the original dense forest area in this region in which dairying was developed between 1870 and 1900. Railways and the dates of their construction are also shown, as is the route of the pioneer explorer, McDonald, in 1862. Today little forest remains.

other settlements in this forest area. Dense jungle, through which pack tracks only could be cut, was made available to settlers at a charge of £1 per acre, and payment was spread over a long period of years. Wages at the time were 15s. to £1 per week and keep, and on that basis the clearing of the scrub country cost £1-£2 per acre for cutting, £4 for picking up and burning. Even then a large number of the giant trees were merely ring-

12. *The Land of the Lyre Bird*, a compilation published by Gordon & Gotch.

(*Aust. National Publicity Assn.*)

Plate 1. Mustering sheep



(*H. V. McKay Massey Harris Pty. Ltd.*)

Plate 2. Five-furrow stump-jump plough

Each mouldboard has an independent action. The stump-jump principle was invented by R. B. and C. H. Smith about 1876 in South Australia.

(H. V. McKay Massey Harris Pty. Ltd.)

Plate 3. Ploughing virgin Mallee land by spring-controlled stump-jump plough

(Dr. R. T. Patton)

Plate 4. Mallee vegetation in natural state

(*Aust. National Publicity Assn.*)

Plate 5. *Dingo*

The 'wild' dog attacks sheep and even young cattle. Bounties are paid for dingo scalps.

(C'wealth Cinema and Photographic Branch)

Plate 6. Pioneer dairying country, South Gippsland, Vic.

The dead ringbarked trees are a common feature of the Australian pioneer farms.

(*Dept. of Agriculture, Tas.*)

Plate 7. Apple and pear orchards, southern Tasmania

(*C'wealth Dept. of Information*)

Plate 8. Aerial photo of irrigated vineyards and orange groves, Red Cliffs, Vic.

(*Aust. National Publicity Assn.*)

Plate 9. Savannah woodland between Alice Springs and Darwin, N.T.
Note the huge ant hills.

(M W Miles)

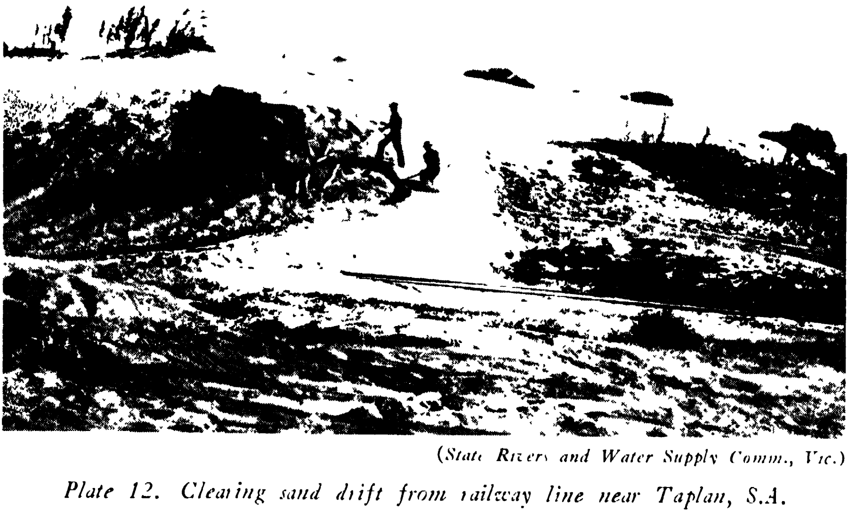
Plate 10. Subterranean clover pasture in flower

In southern districts with a relatively high rainfall the application of superphosphate makes the establishment of subterranean clover possible on many poor soils which normally carry only an inferior vegetation.

(*Associate-Professor G. W. Leeper*)

Plate 11. Wind erosion, Wakool, N.S.W.

Note 'scalded' patches of exposed clay from which the surface sandy loam has been blown.



(*State Rivers and Water Supply Comm., Vic.*)

Plate 12. Clearing sand drift from railway line near Taplan, S.A.

Note bamboo growing on top of the sand hill, an early method of protection.

barked and left standing, to fall as time went by (Plate 6). Expenditure of this sum left the ground encumbered with large numbers of fallen trees and standing dead timber, but rye grass, cocksfoot and clovers could be planted on the ashes of the burn, and gave a very luxuriant growth. It was soon found that the rough pastures so developed were very effective for fattening stock or dairying, but difficulties usually emerged in the summer, when grasshopper plagues appeared and swept away the pastures, a state of affairs which continued until starlings were introduced and kept down the numbers of these insects. Dingoes[13] (Plate 5) were prevalent, attacking sheep, and,

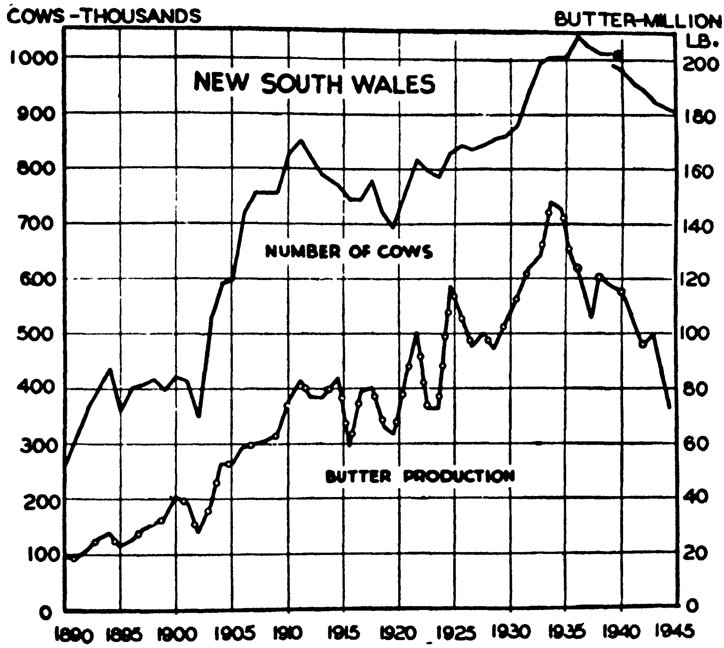


Fig. 8. Progress of Dairying in New South Wales

In this and the succeeding graphs, the data for the number of cows include those used for production of whole milk as well as those for butter-fat and cheese. The break in the graphs for number of cows in this figure and Nos. 9 and 10 is due to a slight change in the definition of dairy cows used by the Statist.

in the winter, even calves; while the depredations of eagles on lambs were considerable. Life was made additionally exciting by the presence of a large number of poisonous snakes of various species, while gnats and mosquitoes abounded, and scorpions were by no means rare. Under these circumstances it is not surprising that a considerable proportion of the early settlers gave up the struggle and abandoned their blocks. It was a virtual impossibility for

13. Wild dogs descended from animals imported by aboriginals.

any man to develop this country unless he started with some capital resources. Individuals who were not so favoured could only succeed if they spent a number of years in the district, doing contract work for their more fortunate neighbours, but the local demand for this labour was by no means large.

During the early 'eighties the produce of the farms was small and of little commercial value. A few cattle were fattened, but a shortage of pasturage during the period January to March was usual; and, as a general rule the herds were small and the prices realized low, except in those years when the better-known cattle districts in the north of the state were afflicted

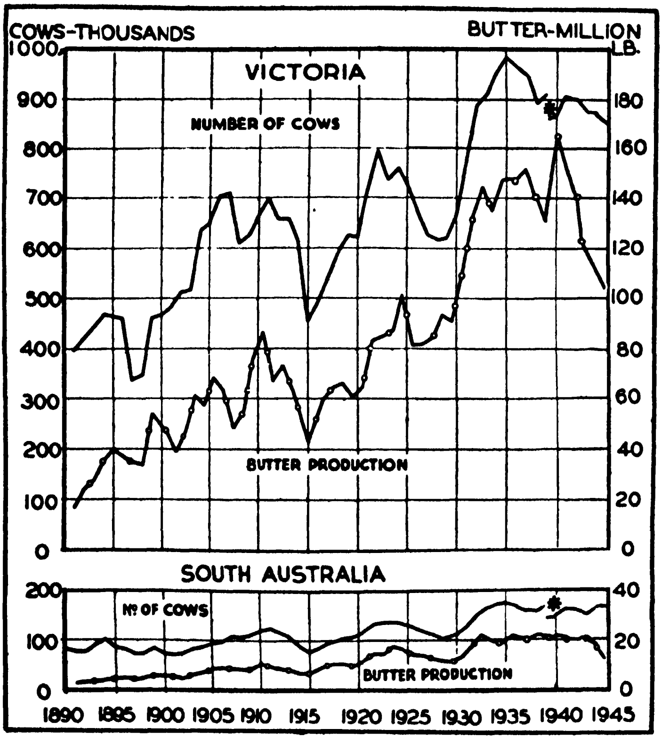


Fig. 9. Progress of Dairying in Victoria and South Australia

Rapid expansion of the industry between 1915 and 1922, and again between 1929 and 1935, should be noted.

with drought. The introduction of three separate machines after 1880 effected a revolution in the prospects of the district. The first of these inventions was refrigerating machinery, upon which experiments had been proceeding for some time. The second development was the introduction of the cream separator, first introduced into Sydney in 1883, the use of which spread rapidly through Australia. Finally, the Babcock testing machine provided a method whereby the farmer could be paid on an equitable basis for

the value of milk or cream which he supplied. These three inventions made it practicable for butter to be made under factory conditions, and in 1892 a butter factory was started at Poowong. Others followed at Bena and Leongatha shortly afterwards. Rough roads were also developed for the transport of produce from the farms to the factory centres, although in many cases the more distant farms were served for the next thirty years by the merest of tracks through dense bush, and for decades both packhorses and sledges were used for the transport of materials and produce in the winter months.

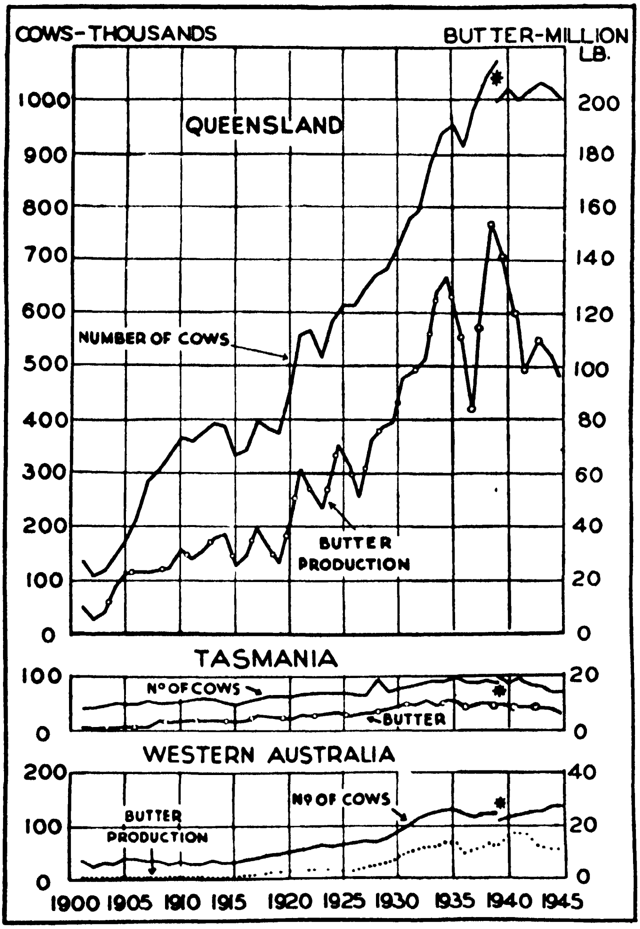


Fig. 10. Progress of Dairying in Queensland, Tasmania and Western Australia

The curve showing number of cows in Queensland is remarkable for its rapid rise, with few of the large fluctuations shown in the other dairying states, viz., Victoria and New South Wales. The growth of dairying began later here, and major fluctuations, such as the 1914-15 drought, had relatively little effect on numbers.

The coming of the railway altered the outlook. The South Gippsland line was opened in 1891, and afforded a link between the country and ports of shipment. Under these circumstances, the district began to progress with steadily increasing momentum. There was now an economic future for the produce, because, under the factory system, it was practicable to make a more or less standard type of butter, while the installation of refrigerated holds in oversea ships made it possible for the produce to reach markets in which the price fluctuations were less marked. This progress was reflected in the rising value of the land.[14]

For reasons of convenience, attention has been concentrated upon Gippsland, but a similar sequence of events was taking place in many of the areas which are now first-class dairying districts—for instance, in the northern coastal section of New South Wales and in the deep red soil (krasnozem) areas, the chief of which are indicated in the soil map (Fig. 25). The Darling Downs, in Queensland, were also being developed. It is interesting to note that, as in the case of the wheat industry, dairying also required attention to a whole series of factors before it could become established as an effective stimulus to settlement. Unfortunately, the earlier statistical records do not separate dairy cows from other cattle, so that it is impracticable to give a complete statistical picture of the expansion in this form of rural production. Such data as are available have been shown in Figs. 8, 9 and 10.

5. THE DEVELOPMENT OF OTHER RURAL INDUSTRIES AND IRRIGATION

The discovery of refrigeration, which was of such great significance to the dairy industry, was equally important in stimulating a number of other forms of rural production. After 1885 it was possible for Australian farmers to export any perishable commodity to the markets of the world, provided that such a product would withstand a long period of cold storage, and also provided that the price at which the product could be sold in the world's markets would pay for the cost of the initial production and processing of the material.

One of the first industries to be profoundly affected by this new development was that of **meat production.** Large numbers of cattle had been kept in Australia from the early days, partly because the population consumed large quantities of meat, and partly because there were large tracts of country unsuited to sheep but suitable for cattle. Before refrigeration, the only use of these cattle, apart from the local consumption, was for the

14. Whereas it is recorded that in 1881 a block of 150 acres of cleared land, with a house, was only worth £2.10.0 per acre (a sum considerably less than the actual cost of putting the improvements on the land), yet during the period 1894-1904 land values went up by £1 per acre per annum, and in 1914 it is stated that £20 per acre was a reasonable price. In 1940, as a result of pasture improvement, £30-£40 per acre was ordinarily paid, while specially good farms often brought much higher prices.

production of hides or for rendering down into tallow, although it is true that a certain amount of salt beef was sold for use on ships or found its way to world markets. Under the new conditions, it became practicable for the meat industry to develop on an entirely new basis. The new market, moreover, exerted a stabilizing influence on the price, and, at the same time, gave an impetus to expansion in production and the utilization of certain outback

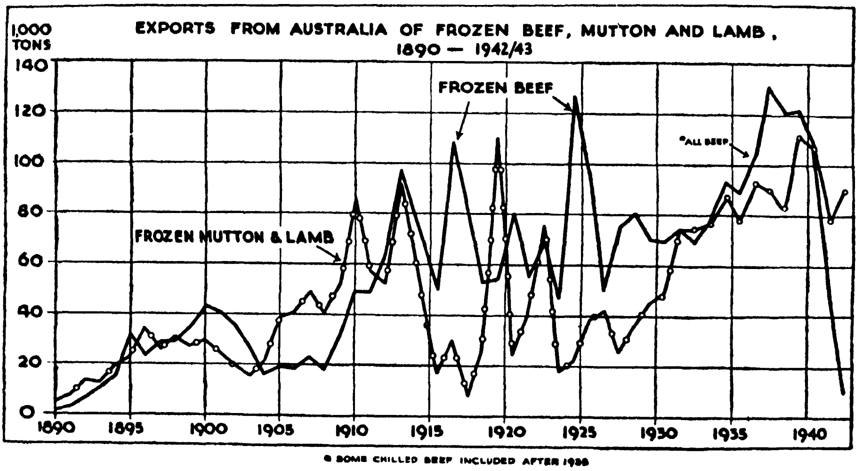


Fig. 11

The extreme seasonal irregularity of production, which became so pronounced between 1908 and 1930, has been the chief difficulty in building up a steady export trade, since British distributors object strenuously to such wide fluctuations. More regular shipments were made between 1927 and 1939. During World War II much of the beef was diverted to use by armed forces of Australia and the U.S.A.

areas. Fig. 11 shows the exports of beef, mutton and lamb from 1890 onwards. The new development was of considerable value to the sheep industry, as it opened a fresh source of income. The implications of this change in connection with the type of sheep kept and methods of management will be discussed in chapter IV, dealing with the wool industry.

There are no indigenous **fruits** of any value in Australia, and all the fruits grown commercially have been raised from parents originally imported into the country. The early development of the fruit-growing industries was a very haphazard process. Settlers, mainly from the United Kingdom, brought with them fruit trees or seed from their old homes, and raised them round their houses, in small orchards, for domestic use. Commercial as distinct from domestic orchards were planted fairly early in the history of settlement. These were almost invariably adjacent to the cities, in order to facilitate access to markets under somewhat primitive conditions of transport. Commercial orchards were placed in areas of fairly high rainfall, where the

growth of the natural vegetation and the high cost of clearing the land made intensive culture essential in order to ensure an adequate return.

The older fruit-growing districts of Tasmania are the best example of this process. In the valleys of the Derwent, Huon and other rivers the planting of apples, and to a lesser extent of pears, affords an interesting example of the use of highly productive land for growing fruit (Plate 7). These areas were planted originally with many of the older English varieties

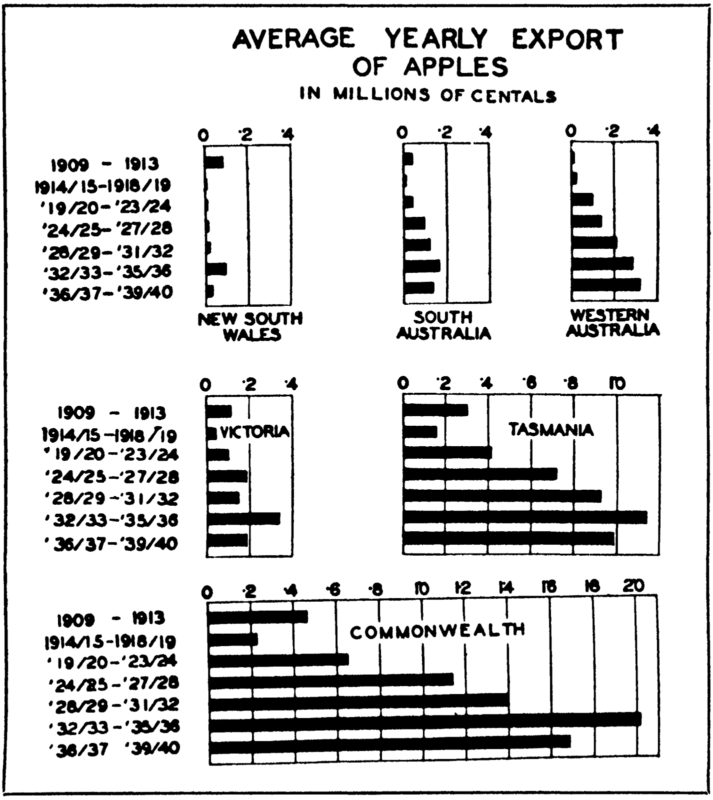


Fig. 12

of apples, which today have practically no commercial value. Lane's Prince Alfred, Ribston Pippins, French Crabs, etc., still bear, and are still sold, but their place has gradually been taken by newer varieties, many of which were introduced from North America. In Victoria, the older districts are in Gippsland, the Mornington Peninsula, and at Harcourt. In South Australia, the older districts are in the hills north and east of Adelaide, and fairly close to the metropolitan market. 'Commercial' fruit-growing in Western Australia, New South Wales and Queensland is, generally speaking, a more recent development.

Markets for apples and pears were generally available in the home state for all the fruit produced, or, if not, interstate markets could generally be found without great effort. Tasmania, with a smaller population than its vigorous neighbours, developed an apple export trade to New South Wales and Victoria. The increase of population in Victoria after the gold rush of the 'fifties built up a fairly substantial market in Melbourne. The state of Victoria, however, had adopted a protective policy, and sought to shelter its own growers from Tasmanian competition by a tariff. This compelled the Tasmanians to seek other markets, and small quantities of Tasmanian fruit began to find their way to England. The seasons were directly opposite to those of the northern hemisphere, and, if the difficulties of carriage could be overcome, there appeared to be distinct possibilities of expanding the trade. The fruit, however, was by no means certain to arrive in an edible condition. The first large consignment (400 cases) was carried in 1884 as ordinary cargo. In 1887, the first cargo carried in cool storage was sent, when 1,300 cases were shipped, and was apparently carried at about 55 degrees Fahrenheit. In 1888, about 20,000 cases were exported in refrigerated space. Fig. 12 illustrates the expansion in the apple export industry.

The **vine** seems to have been introduced into Australia at the time of the first settlement in New South Wales, and the earliest record is a report by Governor Hunter, giving the area under vine cultivation in 1797 as eight acres. From New South Wales, vine-growing spread to Victoria and to South Australia, which gradually became the chief grape-producing state. Little progress has been made in Queensland because of summer rainfall conditions, or in Western Australia, because of limitation to a local market. The climate of Tasmania is too cold to allow the grape to ripen. Before Federation in 1901 the Customs duties then operating effectually prevented interstate trade in wine, and production for a relatively small local market was the rule. In 1900, the quantity of wine made in Australia was estimated at three and a half million gallons, and it remained at about that figure for many years.

Another development affected the wetter portions of the northern part of the continent. This was the expansion of the **sugar** industry. On the better soils of the Pacific seaboard, in northern New South Wales and in Queensland, attempts were made to grow sugar after 1850. During the 'seventies expansion began, and indentured natives known as Kanakas[15] were obtained from the Pacific Islands to work the sugar estates then existing. The industry developed gradually, as is shown in Fig. 13, which deals with the acreage under the crop and the raw sugar produced.

When federation of the states was accomplished in 1901, and the White Australia policy became accepted as one of the fundamentals of the new Constitution, it was agreed that the Kanakas should be repatriated. In order

15. Polynesian word for a man.

to ensure permanence under the new conditions, a measure of protection was afforded the industry, which was then producing half Australia's sugar requirements. During World War I an embargo was placed upon the importation of foreign sugar, and the Commonwealth government agreed to some measure of price-fixing. This measure of assistance to the industry remained during the post-war period, and has been extended from time to time. Under its stimulus the industry expanded very considerably, and even entered the export market. The areas devoted to sugarcane have shown a tendency to move northwards, many of the more southern districts being gradually handed over to dairying. This movement has largely been due to the fact that the more reliable rainfall in some of the northerly coastal districts enabled sugar production to be carried out on a better economic basis.

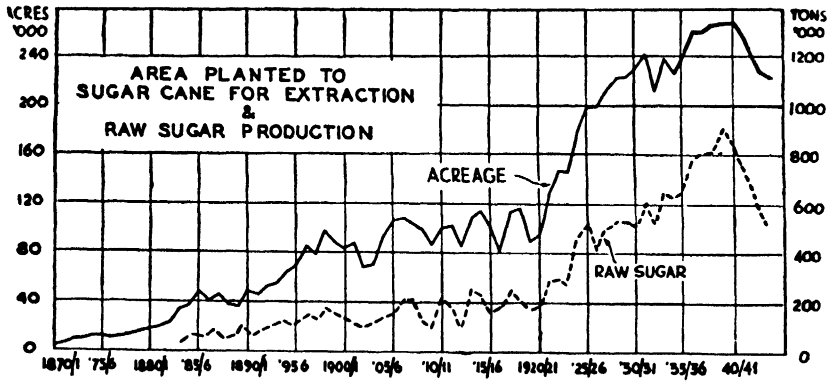


Fig. 13

Note the expansion of productive area which followed the agreement on sugar developments between the Commonwealth and Queensland governments, which began in 1915.

The great difficulties which had been experienced by many of the farmers during periods of protracted drought naturally turned attention towards **irrigation.** Lack of efficient rainfall was held to be the explanation of many failures; consequently it is not surprising that, when once responsible government had been granted, and had commenced to function, the possibilities of irrigation were seriously considered. Numerous small schemes were started in Victoria after 1870; and, as the land on the River Murray became devoted to a greater extent to agricultural purposes, irrigation was enthusiastically developed. For a time, local water trusts carried on the work, but it was found in most cases that they had neither the resources, the foresight, nor the knowledge to work the schemes effectively. The most noteworthy private schemes were those promoted by the Chaffey brothers, who came from California, and started the irrigation settlements at Mildura

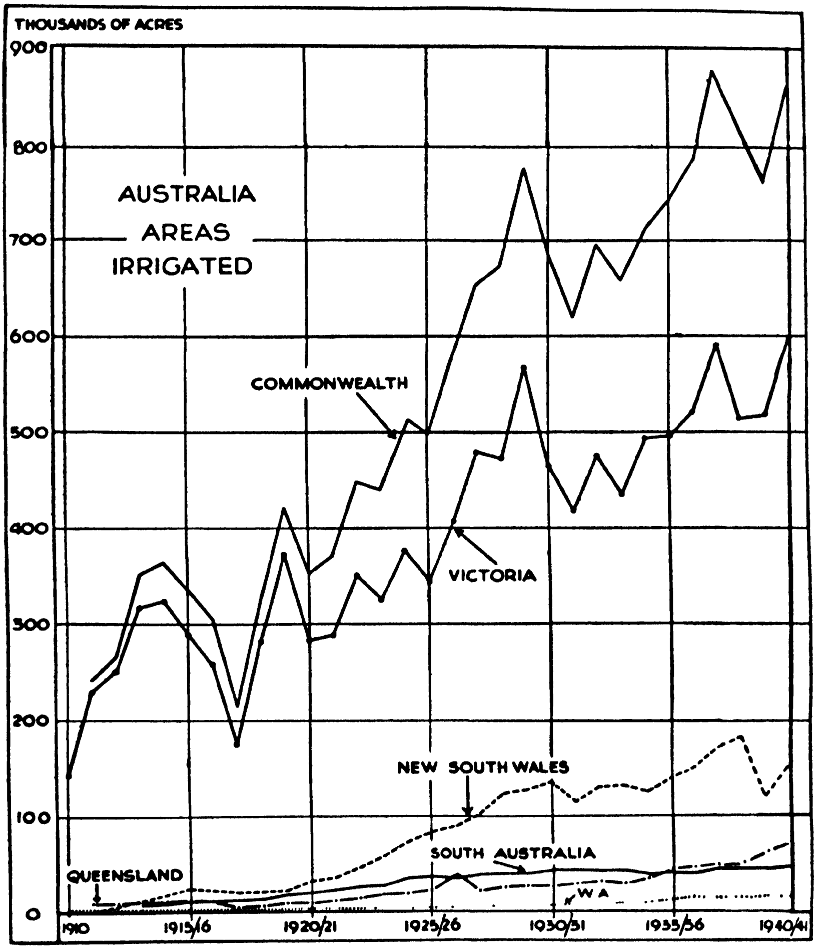


Fig. 14

In the above graph irrigated acreage for New South Wales does not include pastures. No figures are available for the later war years, but in 1945-46 season the following acreages were irrigated:

Victoria . .	656,845	
New South Wales	301,741	(including 104,269 acres of pasture)
South Australia	42,192	
Western Australia	16,864	
Queensland	68,347	
Tasmania	11,279	

(Victoria) and Renmark (South Australia) in 1887 (Fig. 70). Gradually the states were forced to take on more and more responsibility in connection with the development of irrigation schemes. In 1914 the governments of New South Wales, Victoria and South Australia agreed to reconcile navigation and irrigation developments in the River Murray basin. The area of

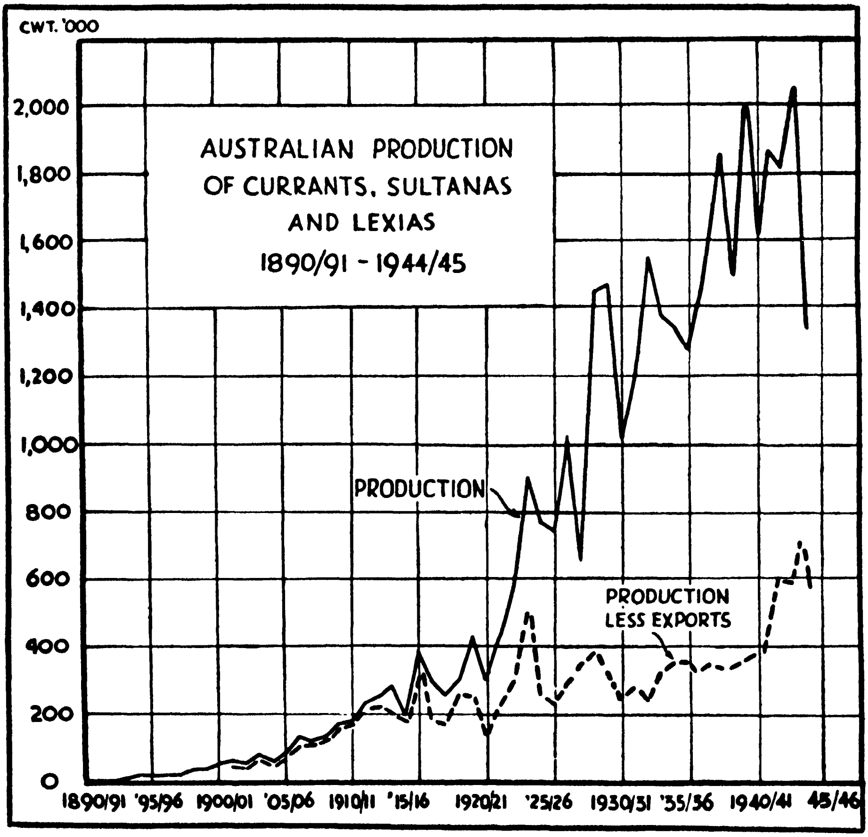


Fig. 15

The great expansion of the dried vine fruit industry after World War I was due to soldier settlement, mainly in the irrigation areas of the Murray Valley.

land under irrigation in the various states has shown a considerable increase as a result of these developments, as is indicated in Fig. 14.

Irrigation will be considered in more detail in chapter XIII, in which its effectiveness will also be discussed. It is sufficient here to remark that the schemes have not been uniformly successful. The development of this new type of rural activity naturally resulted in profound changes in the method of land utilization in the districts concerned. Where water is cheap it has been found practicable to develop orchards supplying fruit to canneries or

special pastures for dairying. On other farms the meat industry has been stimulated by making reliable supplies of fattening feed available for certain classes of stock. Where the supply of the water is more expensive, cultivation of vineyards or the production of citrus fruit has developed (Plate 8). In a narrowly localized portion of the Murrumbidgee irrigation area (Fig. 70), rice production was developed to a sufficient extent to supply the requirements of the Commonwealth between 1927 and 1940, while a further extension was made in the Wakool irrigation area under war conditions.

The development of the **dried vine fruit** industry can best be judged by Fig. 15. Prior to 1887 the only dried fruits produced in Australia were grown in insignificant areas, under dry farming conditions. Practically all the dried vine fruit consumed in Australia was imported, with the exception of a few currants grown in South Australia. The development of the irrigation areas on the Murray, and in particular those of Renmark and Mildura, introduced the possibility of growing vines easily in districts where rainfall and atmospheric humidity are relatively low during the autumn period when the fruit is maturing and drying takes place.

The early plantings at Mildura and Renmark consisted mainly of stone fruits, citrus and raisins; sultanas were not included until later years. These plantings gave the first harvest in 1891, when eighty-two tons of raisins and one and a half tons of currants were produced. Thereafter advance was steady in Victoria, but rather slower in South Australia. During this early stage the industry encountered difficulties which threatened to wreck the whole scheme. Every grower packed his own fruit, and had his own selling agent in the metropolis. Under these conditions, the competition between the agents forced prices down to unprofitable levels. The growers were quick to appreciate the gravity of the crisis, and in 1895 they organized the Mildura Raisin Trust, which imposed a system of control over marketing by permitting only two agents to handle the fruit of that district. Fired by this success, the South Australian growers in the next year formed the Renmark Raisin Trust. These Trusts later extended their control to cover all varieties of dried fruits. These developments took place before federation in 1901. At that time any fruit transported from one state to another was subject both to Customs duties and to competition from foreign imports. Evasions were inevitable; for instance, in 1899, the Mildura growers ferried Victorian-grown grapes across the river and dried them in New South Wales.

Oranges and lemons were introduced into Australia at an early date, and, after some experiment, certain districts were found to be particularly suitable for their cultivation. The development of irrigation areas in the drier, warmer districts opened new possibilities for such types as the Washington navel. The brothers Chaffey brought with them from California a few selected trees of this strain, and in the Murray irrigation areas and elsewhere some first-class groves have been budded from this stock, and have proved

their capacity to produce fruit of high quality. Fig. 16 shows the irrigated acreage under citrus fruit for the period 1897-1945.

This sketch of the general history of the chief developments in land use and the factors which brought them about only deals with the main types of production. During the whole of the period a steady growth of population naturally increased the local market for many other rural commodities. Nothing has been said about the development of such crops as maize, barley,

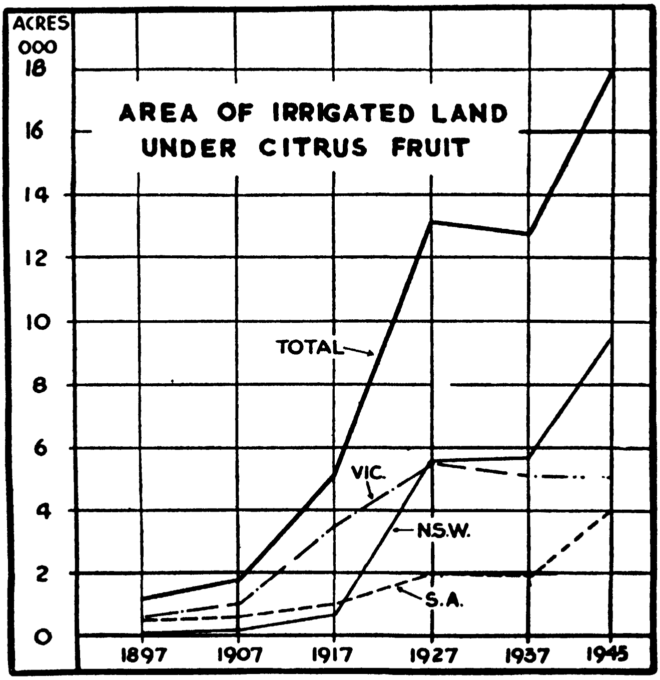


Fig. 16

oats or potatoes, because so far these have been the necessary adjuncts of the population as a whole, and their production has been, for the most part, limited by the needs of that population. One of the implied purposes of a land utilization study is to indicate the margin which exists between actual and potential standards of living at which land will support its people. In this preliminary consideration the persistent control exercised upon settlement by the presence or absence of opportunities for exporting the products of the land has been emphasized at every stage. The connection between men on the land and markets, between primary-producing population and world prices, has been steadily kept in view. It may be an approach that is open to criticism, but, at least, we believe it is realistic and fundamental in a country at Australia's stage of development and with all the disadvantages which are inherent in its distance from developed markets.

Chapter III

NATURAL FACTORS CONTROLLING THE USE OF LAND

1. Climatic Considerations
2. Topography
3. Soils
4. Costs of Clearing
5. Relation of Clearing Costs to Market Values of Improved Farms

CHAPTER III

NATURAL FACTORS CONTROLLING THE USE OF LAND

1. CLIMATIC CONSIDERATIONS

THE broad historical survey of the preceding chapter was intended to throw into relief the development of the rural industries which are characteristic of the continent. The agricultural tradition, economic conditions, character and number of the people, industrial techniques, political structure and social ideals of a country are the elements which determine the complex history of settlement. Before the details of the present development of land utilization can be appreciated in their true significance, however, the powerful and persistent influences of the natural conditions must be considered. Environment is both a control and a challenge to man's inventive capacities, and land utilization in its broadest sense represents a response to relatively unchangeable conditions of climate and soil, surface and area.

It has long been recognized that, in a general way, the controls determining the use to which land may be put are the conditions which limit the capacity of plants and animals to live and grow in the area concerned. The influences favouring survival are constantly in combat with the factors working for extinction. Plants and animals flourish if the net balance of favourable influences over unfavourable is considerable, and vice versa. For any area these factors may be observed and charted empirically.

The Temperature Factor. Some students of the effect of climate have based their work on the maxim that 'it is to temperature that we must look as the most reliable guide to the preliminary interpretation of the distribution of vegetational and other living types.'[1] Such a consideration would naturally occur to those who are studying countries where a long cold period forms a dominant part of the yearly climatic cycle. The fact that intensive study of this kind has mostly been carried out, in the first place, in countries where such conditions exist is probably responsible for the traditional classification of climates. Some writers have defined broad climatic types on the basis of temperature alone, but temperature as a sole criterion is both inadequate and misleading. Naturally, the distinction between any two adjacent climatic zones must be somewhat arbitrary, since one zone invariably merges imperceptibly into the other. The broad distinctions adopted by Miller may be accepted as sufficiently accurate for our purpose.[2] He distinguishes, *inter alia*, three zones which embrace the whole area of Australia. Stated briefly, these climatic types are:

1. Hopkins, A. D., *Monthly Weather Review*, U.S. Dept. of Agriculture, Vol. XLIX, No. 5.
2. Miller, A. R., *Climatology*, p. 68 (Methuen).

A. Hot; i.e., mean annual temperature above 70 degrees F.
B. Warm temperate; i.e., no month with mean temperature below 43 degrees F.
C. Cool temperate; i.e., 1-6 months below 43 degrees F.

It is interesting to note that the limit of type C, 43 degrees F., is approximately the lowest temperature at which ordinary mesophytic plants are able to grow effectively. Nearly the whole of Australia falls into the first two of these temperature zones, so that for our purpose a subdivision based on them is of little value. For the Australian environment the moisture factor must be regarded as a far more crucial biological test.

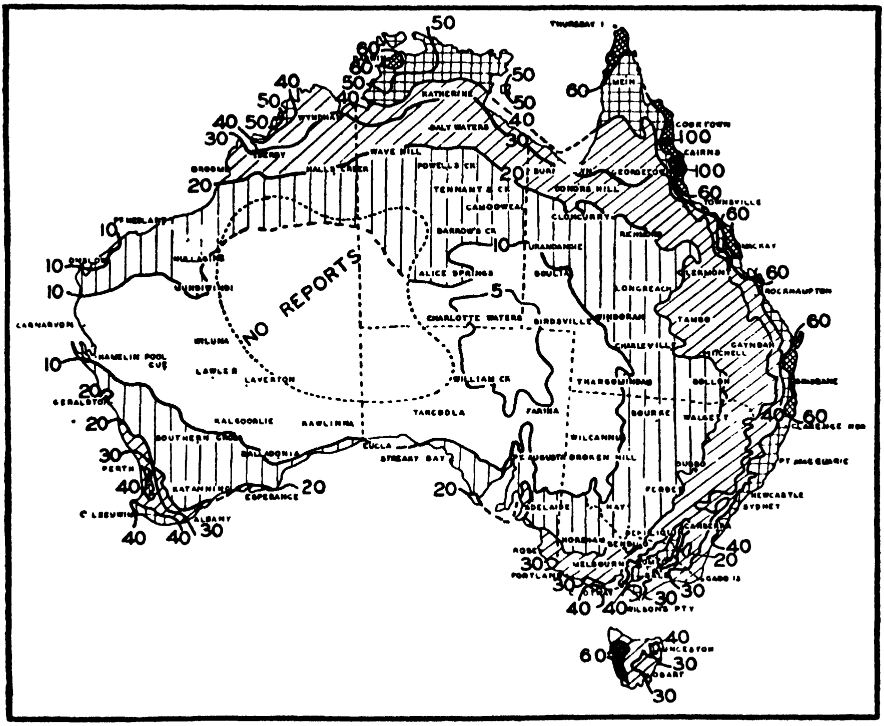


Fig. 17. Average of Recorded Annual Rainfall in inches up to 1938

The Rainfall Factor. The earlier studies of the Australian environment concentrated largely on the measurement of the rainfall. The frequency with which some part or other of the continent was affected by drought has built up a definite 'drought complex' in the Australian mind, and farmers as well as pastoralists have developed the habit of thinking in terms of average annual rainfall. Fig. 17, which has been adapted from the latest map prepared by the Commonwealth Weather Bureau, shows how large a part of the continent is afflicted with a low annual rainfall—one million out of a total

of three million square miles has an average of less than ten inches. It is interesting, also, to compare the extent of higher rainfall in Australia with that in the United States of America, which has approximately the same total area. Australia has 194,000 square miles with an average of over forty inches, while America has 826,000 square miles.

The next point of importance in connection with summer and winter distribution of Australian rainfall (Figs. 18a, 18b). In the north, where the

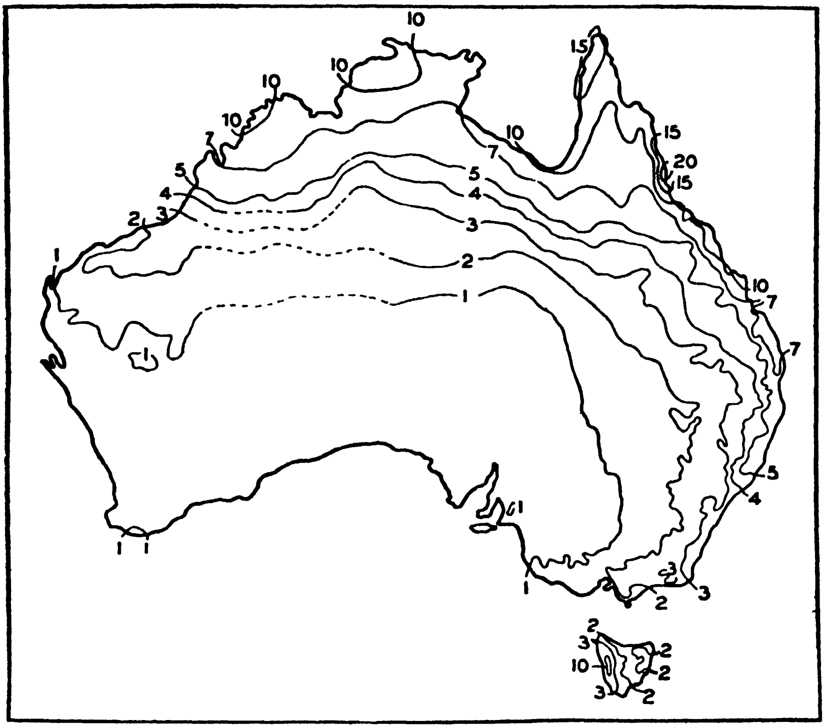


Fig. 18a. Average Rainfall for January, in inches

tropical monsoonal influences are chiefly responsible for the rain, there is a marked hot-season maximum. Many parts of the south-west of Western Australia and of South Australia have sharp winter peaks in their rainfall curves. Between these two extremes there are all stages of transition, most of New South Wales having the same average rainfall for every month in the year (Fig. 43). This seasonal distribution has great significance in determining the kinds of plants which are able to grow in each district. The maps (Figs. 41 and 43) which have been prepared in connection with the pastoral and wheat industries will illustrate the way in which the distribution of the rainfall changes from month to month in a number of different localities.

The detailed result of this monthly distribution of rainfall on the pastures and on the crops will be discussed in later sections.

This distribution of rainfall is associated with two main storm systems: the antarctic, which is most active during the winter in the south, and the tropical, which is active during the summer in the north. The middle

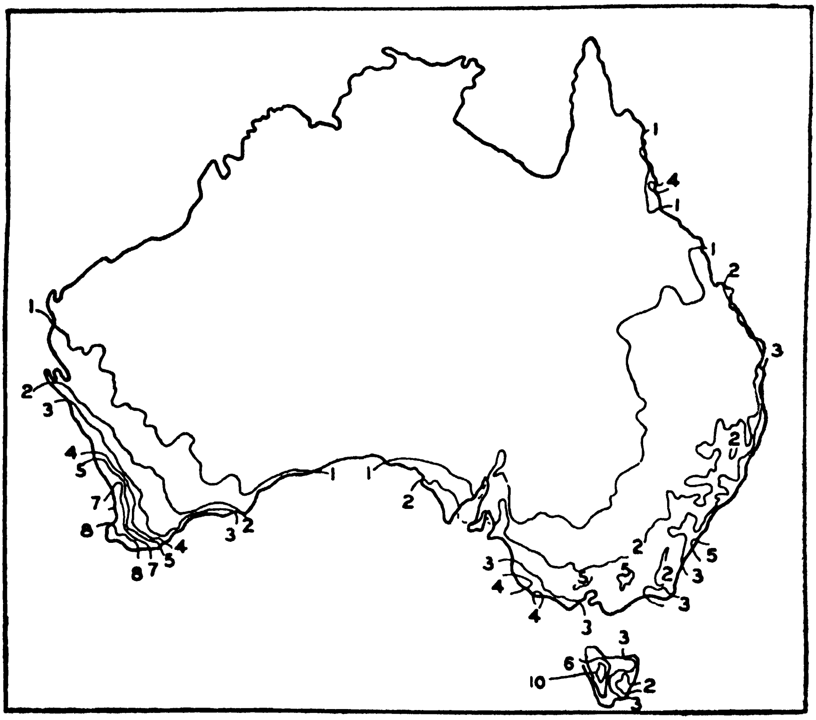


Fig. 18b. Average Rainfall for July, in inches

latitudes of Australia (apart from the eastern districts within range of the Pacific Ocean) are dry for the simple reason that they lie outside the regular tracks of both southern and northern rainstorms. The corresponding latitudes in other continents are also dry. This is mentioned here because Dr. Bradfield's proposals for irrigating a portion of the dry Inland (see p. 306) were associated[3] with the claim that the consequent additional evaporation would lead to an increased rainfall in the same region. There is no substance in this claim. The additional vapour so brought into the Inland would be small in any case, and there is no reason to expect it to produce rain in that region. The most conclusive answer to all such proposals for changing the climate is the fact that deserts lie on both sides of the Red Sea.

3. See *Australian Quarterly*, March and June, 1942.

Variability of Rainfall. The average annual rainfall can be misleading, since the variations from the average can be very great. The variability is best shown according to Griffith Taylor (Fig. 19). The percentage variability, or mean deviation per cent of mean, shows the general relation that

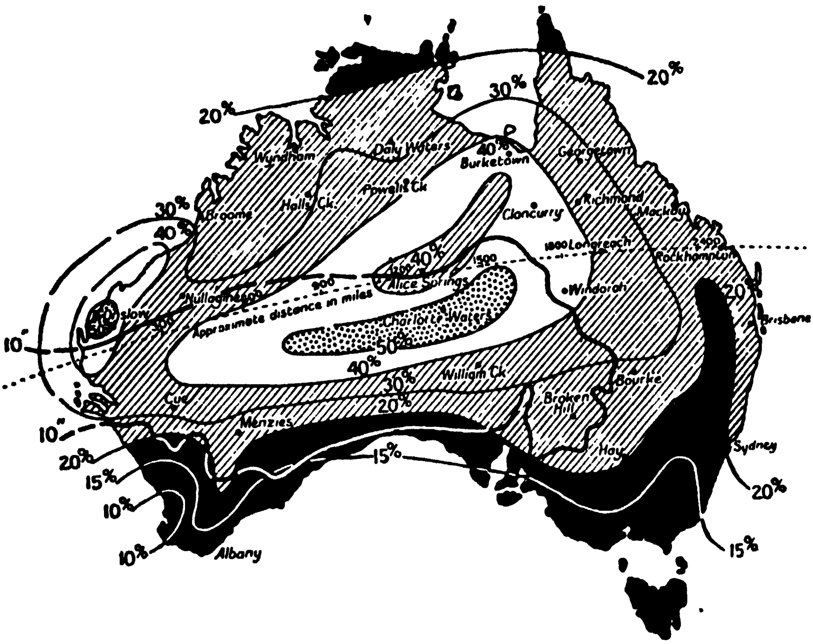


Fig. 19. Rain Variability for Australia (from Griffith Taylor)

The annual rainfalls for twenty years (1891-1910) were tabulated, and their departures from the mean obtained in each year. These departures (ignoring sign) were then averaged, and the result expressed as a percentage of the total rainfall. Thus at Sydney the average rainfall for 75 years is 48·5 inches. The average departure is 9·5 inches, or 20 per cent. This last figure is plotted on the chart.

variability is high where rainfall is low. It is not so simple as this, however. The area of high variability not only includes the dry centre of the continent, but also extends to the central Queensland coast, where the average rainfall exceeds 40 inches. An area of extraordinarily high variability, the reason for which is not known, occurs at Onslow, in the north-western corner of the continent.

Fig. 20 has been drawn in order to show how erratic Australia's rainfall is by world standards. This shows the extent to which the variability differs from the average value found in other parts of the world. For example, the average world value for the variability of a 20-inch rainfall is

18 per cent. Bendigo in Victoria has 21 inches with a variability of 15 per cent, or minus 3 by world standards, while Daly Waters, in the Northern Territory, with the same average rainfall, has a variability of 25 per cent, or 10 more than normal. When such deviations as these are plotted, it appears that the only part of Australia where the rainfall is more reliable than the world normal is the winter-rain belt from south-west of Western Australia (Swanland) to Victoria (all with negative deviations), while over half of the continent is more than 10 per cent worse than places of the same

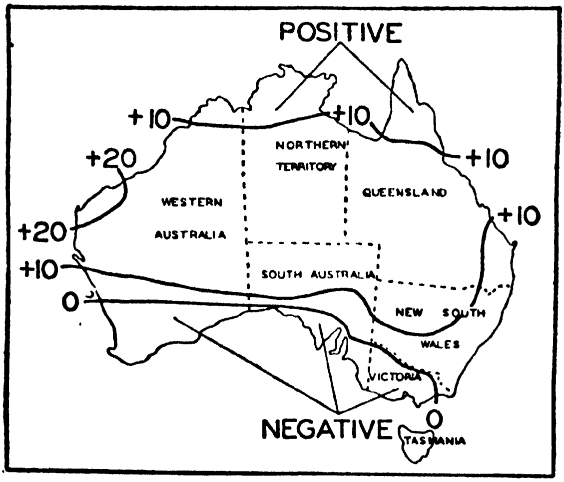


Fig. 20. Variability of Rainfall
Percentage Departure from World Standards

This map summarizes the material discussed by G. W. Leeper in *The Jour. of the Aust. Inst. of Agricultural Science*, Vol. II, No. 4, 1945. The 'World Standards' are taken from a study by V. Conrad, *Monthly Weather Review*, 69: 5, 1941. They are as follows:

Average annual rainfall, inches	5	10	15	20	30	60
Expected percentage variability .. .. ('World Standards')	31	24	20	18	17	15

average rainfall elsewhere in the world. Nowhere in the world is there such a huge area of pastoral land of such erratic rainfall as this pastoral country of Australia.

Percentage variability, as discussed here, is interesting for comparative purposes. However, the practical method of expressing variability, which can be derived from the above figures, is to show how frequently the rainfall will lie below a given value. For example, Townsville has an average annual

rainfall of 46 inches; the total there falls below 40 inches four times in ten years, below 35 inches three times in ten years, and below 30 inches once in seven years.

The Public Works Department in Western Australia has investigated the probability of droughts in that state. Records have been obtained for twenty-one rural stations with the longest records of rainfall. These stations are well spread over the area of the state in which extensive land utilization is in progress. The liability to drought is indicated on the accompanying diagram and map (Figs. 21 and 22), in which the vertical scale shows the percentage deficit on the average rainfall, while the horizontal scale shows the years in which such deficit occurred. The size of the rectangles is thus a rough measure of the intensity and duration of drought. The concurrence of rectangles scanned vertically indicates a cycle of rainfall below the average.

If it is assumed that the readings for Perth, Jarrahdale and Walebing were typical of the conditions in the earlier years at other stations for which no records exist, then it appears that a long drought cycle from 1876 to 1915 was succeeded by a shorter, wetter cycle from 1916 to 1935. The fact that rainfall is either, in general, excessive or deficient for a longer or shorter run of years must tend to cause successive waves of undue optimism and depression in the rural industries concerned.

The immediate effects of violent fluctuations of climate on the development of agriculture are considerable, but their ultimate effects are much greater than are normally appreciated. Disasters consequent upon vagaries of climate discourage the continuous organization of rural industry. Consequently, on the commercial side, the fluctuations in the price of produce are necessarily increased, and, at the same time, the instability of supply diverts the demand to other sources. The transport system must be capable of handling the produce of a good season, and is, consequently, excessively elaborate for the needs of a poor year, so that transport costs are increased. Capital is, naturally, somewhat shy of areas of variable rainfall, particularly when it is required for investment in the form of stock, equipment and manures. As a result, farming tends to be organized on exploitative rather than on intensive lines. Consequently, the size of farms tends to be large, and closer settlement is restricted; the better farmers tend to move towards the more reliable areas, while the less efficient, unless possessed of abundant capital, move towards the unstable areas. In addition to all these economic and social results, there is a definite danger of a psychological reaction occurring, owing to the many discouragements which influence a farmer either to speculate wildly or to adopt a lethargic attitude towards his work.[4]

Effectiveness of Rainfall. We have seen that the average annual rainfall may give a misleading impression if variability is not allowed for.

4. These and other points are well made in Leppan, D., *Agricultural Policy in South Africa*, p. 28 *et seq.* (Central News Agency, Johannesburg).

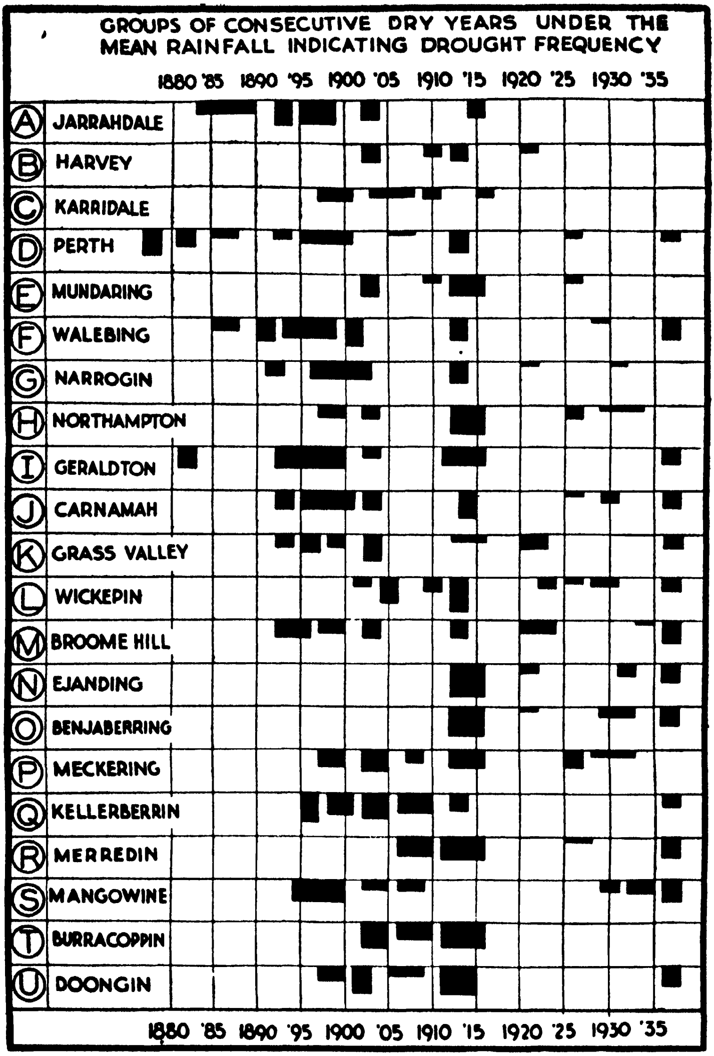


Fig. 21. Drought Frequency in Western Australia

But we must also consider evaporation, since a high evaporation greatly decreases the effectiveness of the rainfall, and most of the continent suffers from high evaporation. One example of allowing for evaporation is seen in the rough boundary that is commonly drawn for the arid region. This lies at an average of ten inches of annual rainfall in the south but at twenty inches in the north (Fig. 17). A more careful and important study of the

effect of evaporation has been made at the Waite Institute, Adelaide,[5] and a map derived from this work is shown in Fig. 23.

In this map each month is treated separately. The rainfall for the month is called 'effective' if on the average it exceeds one-third of the evaporation from a free-water surface.[6] The total number of such months of effective rain is then plotted; these are consecutive except for south-eastern Queensland, where effectively wet months occur in summer and winter but not in autumn or spring.

The large unshaded area contains the central region in which, on the average, no month in the year has ratio of precipitation to evaporation (P/E) greater than one-third. In this region the permanent vegetation must neces-

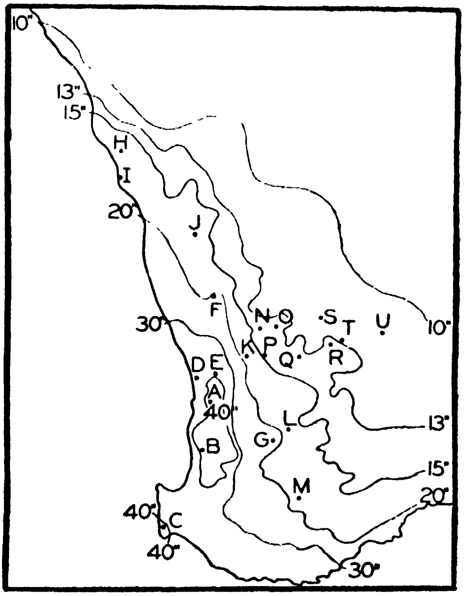


Fig. 22. Key map to places mentioned in Fig. 21, showing the south-west portion of Western Australia, with average annual isohyets in inches

5. See Prescott, J. A., 'The Soils of Australia in Relation to Vegetation and Climate,' *C.S.I.R. Bulletin* No. 52, Melbourne, 1931, p. 32 *et seq.*; Davidson, J., 'Climate in Relation to Insect Ecology, in Australia. (3) 'Bioclimatic Zones in Australia,' *Trans. Roy. Soc. S.A.*, Vol. LX, 1936; Trumble, H. C., 'The Climatic Control of Agriculture in South Australia,' *Trans. Roy. Soc. S.A.*, Vol. LXI, 1937, p. 41, and 'Climatic Factors in Relation to the Agricultural Region of Southern Australia,' *Trans. Roy. Soc. S.A.*, Vol. LXIII, 1939, p. 36.

6. Since evaporation figures are available only for a few centres, the evaporation in inches of water is estimated as 21 times the saturation deficit, expressed as inches of mercury as is common for atmospheric pressure. Thus for Melbourne in January, mean temperature is 67° F. and vapour pressure 0·38 in. Since saturated air at 67° F. holds 0·68 in. of water vapour, the saturation deficit—the additional water which the air could hold—is 0·30 in. The estimated evaporation for the month is thus 6·30 in. of water. Since the mean rainfall of 1·88 in. is less than one-third of this figure, it is counted as 'ineffective'. This estimated figure of 6·30 in. may be compared with the observed figure of 6·42.

sarily comprise species which have developed drought-resisting characteristics. Such characters prevent them from being normal agricultural plants, and in many cases automatically reduce their value for grazing purposes. Ephemeral species may occur in abundance, however, during short periods after the sporadic rainstorms. In the dotted area the average year has one to four

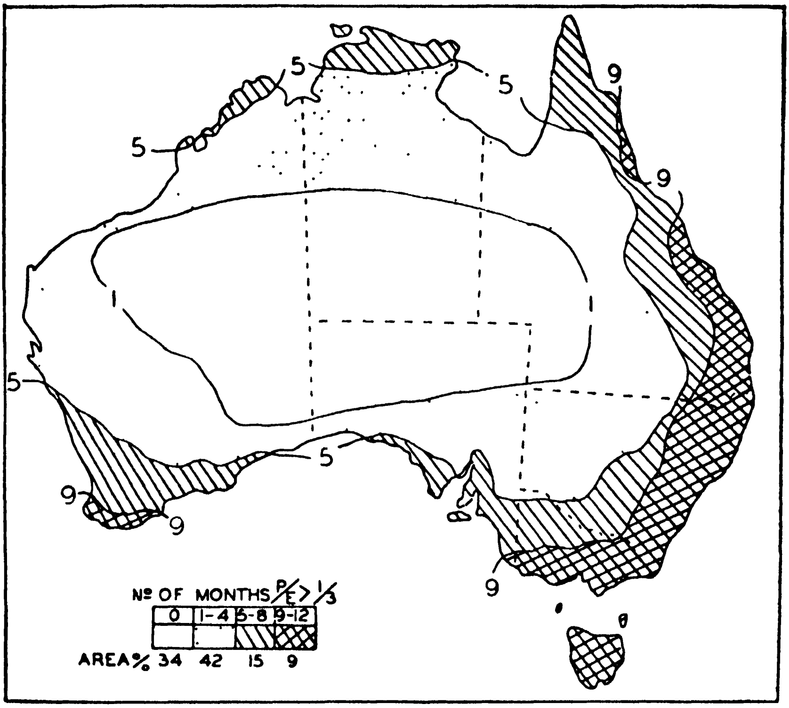


Fig. 23. Length of Growing Period
(Based on the work of Davidson, Prescott and Trumble)

months during which the water relationships are adequate for general plant growth. Some cropping may be a possibility in the outer parts of this zone where soils are favourable, but the rainfall is generally erratic and this makes agricultural operations too speculative. The remaining two zones have, in the average season, five to eight and nine to twelve months respectively during which conditions are suitable for plant growth. These are the areas in which the land may be expected to be used for some type of intensive agricultural or pastoral purposes. Within these zones the soil type becomes of paramount importance in deciding the degree of intensification which is practicable.

The disabilities imposed on farming and pastoral enterprises by the dryness of the climate are in part offset by the very real advantages derived

from its genial nature, which is of such significance to the livestock industries. In very few districts is close housing necessary during the winter. Losses caused by storms, which almost deserve the name of blizzards, occur in some of the southern coastal areas and on the tablelands at times, but these are not sufficiently frequent to demand more than casual precautions.

2. TOPOGRAPHY

The general contours of a country have an immense effect upon the utilization of its land. There are four main directions in which this influence is felt. First, there is the physical difficulty of dealing with rugged country for any purpose other than grazing. In lands which have been used for cultivation for ages it has been possible in some places to terrace whole hillsides, by building rough stone barriers to hold the soil in place and by carrying the soil itself into position. This work has usually been carried out by peasant populations faced with the alternative of famine. On the large scale, it should have no economic justification in a modern world, where international trade is accepted as the natural and reasonable development of human society, and where there is no necessity for a permanent world shortage of essential foodstuffs. Secondly, there is the liability to soil erosion. Next comes the more obscure, but no less important, consideration that on the slopes of ranges composed of certain rocks the soils in their natural state are thin and unfavourable for cultivation, either because the subsoil clay or the rock itself may be near the surface. In scientific terms, this means that the factors of topography and climate have been such that there is no natural tendency to develop a regular depth-profile of a character suitable for the satisfactory growth of high-grade plants. Finally, a difficult topography increases the cost of constructing and maintaining surface transport routes of all kinds. The obstacles to railway construction from the chief seaports in Australia to the country behind the coastal ranges were considerable. At times the road engineers encountered great difficulties in dealing with the various tracts of hilly country. The Murray is the only waterway worthy of mention; it has now been effectively locked and controlled for small craft; but its efficiency as a freight route is definitely limited by the sand-bar at its mouth, and railways have almost entirely replaced river transport.

The actual extent of country in Australia in which the topography is too steep to prevent its effective use for any purpose other than timber reserves or rough grazing by cattle is not known at all accurately; contour maps have not yet been made of large parts of the continent. In Victoria, an approximate figure for the area of mountain ranges is seventeen thousand square miles, or nineteen per cent of the state, but included in this are numerous narrow valleys of fertile soil and a few tablelands which have definite merit for farming purposes of one kind or another. In the other

mainland states the situation is somewhat similar, but the proportion of upland is lower because these states include larger tracts of the dry, central plain system of the continent. In Tasmania,[7] over half the state consists of mountainous, rugged country, unsuitable for permanent settlement, and scarcely capable of exploitation for any agricultural or pastoral purpose.

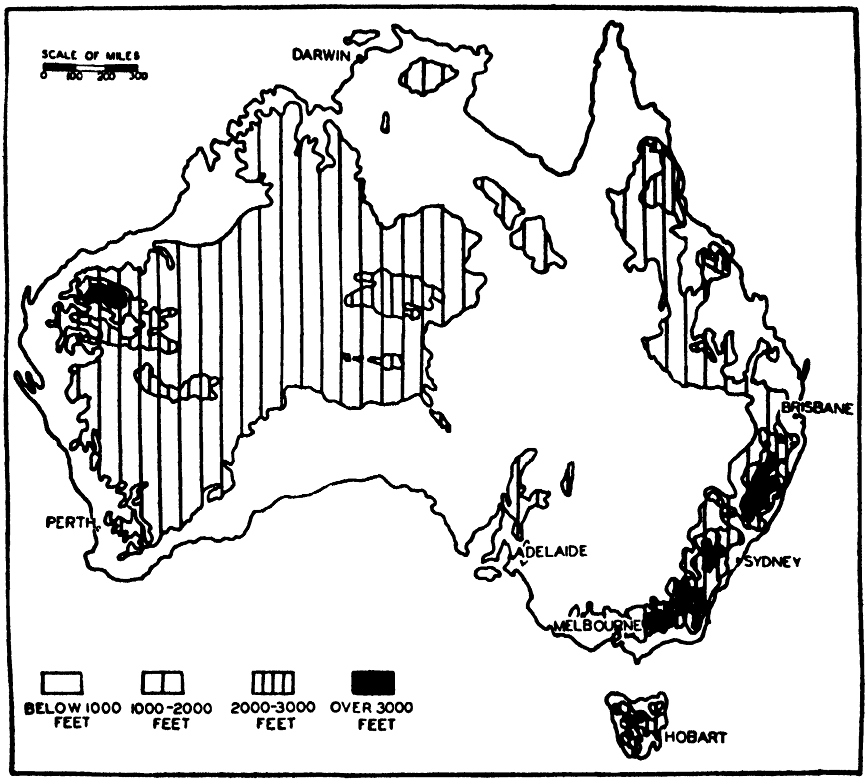


Fig. 24. Contour Map of Australia
(After Commonwealth Meteorological Bureau, 1942)

These inhospitable areas are, for the most part, situated in the very regions where rainfall is high and reliable. This is, of course, a natural consequence of the location of the range country around the coastline. A deduction of one-tenth or of one-fifth of Australia's total land surface from effective exploitation would be immaterial if it were evenly distributed through the climatic zones; it is unfortunate that the topographic obstacles to development should be concentrated in those regions which are particularly favoured in some other respects.

7. Lowndes, A. G., and Maze, W. H., *Land Utilization Regions of Tasmania.* University of Sydney. Publications in Geography, No. 4.

3. SOILS

Any generalizations about soils on a continental scale must sacrifice much detail which may be of great local importance. But if we agree to do this, we find that most continents fall into zones, in each of which a few features are widely found. These zones correspond with differences in climate, in particular with the effective rainfall. This zoning is found in

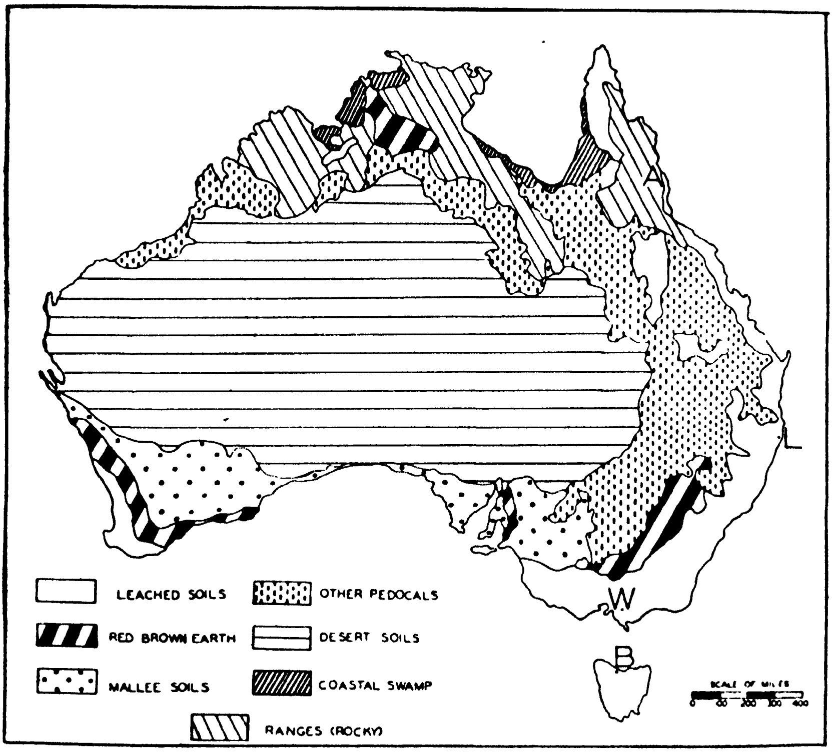


Fig. 25. Simplified Soil Map of Australia
(After Prescott, 1943.)
C.S.I.R. Bulletin No. 177

A = Atherton, L = Lismore, W = Warragul, B = Burnie.
The chief places where deep red soils (krasnozems) occur.

Australia as well as in Russia and North America, the two countries where mapping on a continental scale was first carried out.

In Australia, the pioneer work has been carried out by J. A. Prescott. His revised map of Australia has been used in Fig. 25, but has been greatly simplified.

The *leached*[8] soils correspond with the region of highest rainfall and therefore of most intensive use. Most of the soils in this zone are loosely

8. Leached = washed out.

described as 'podzolic'. This term covers soils which are found in every continent, which have acid *profiles*,[9] consisting of grey sand or loam overlying a yellowish subsoil much higher in clay. The main nutrients, especially calcium and potassium, are low, having been washed into the rivers by the rain, which is also responsible for concentrating the clay in the subsoil. Podzolic soils vary in fertility, the sands being much poorer than the loams, and the acidity may be intense or may be so moderate as not to affect the growth of the typical plants of wetter climates. Generally speaking, they are capable of great improvement wherever the rainfall is high enough to warrant it.

While the typical soil in this zone is podzolic, exceptions are notable.

(a) Most important are the narrow strips of high fertility along alluvial flats. These soils are too young to have been impoverished by the rain, and in many parts of south-eastern Australia they are intensively settled while the neighbouring podzols are left under the native timber.

(b) A few islands of high fertility also occur within a few miles of recently active volcanoes, especially in the Western District of Victoria.

(c) Deep red soils (krasnozems) occur on many plateaus and hilly districts in eastern Australia, notably at Warragul, Lismore, Atherton, and Burnie. These are greatly prized, partly for their rapid permeability to water and ease in working, qualities which are specially desirable under the heavy rainfall of these areas. Some of these soils are highly acid, and their nutrient reserves are low, and it is probable that their reputation is greater than they deserve. Some, but not all, have been formed from fairly old flows of basaltic lava.

In general, the leached soils, though not particularly fertile, have been cleared and brought into use in the southern parts of their zone because they occur in the region of higher rainfall. On the other hand, two other common features greatly lower the value of this zone for agriculture:

(a) Much of it is mountainous, steep or stony. Some of the highland sandstone country of New South Wales is particularly barren. Much of the high country of western Tasmania consists of rocky outcrops alternating with peaty plains. Fig. 24 shows the extent to which the high country of south-eastern Australia coincides with this rugged area.

(b) Some large areas of only moderately elevated land are particularly poor, being covered with ironstone either as massive sheets or as gravel. Examples are found in Swanland, Kangaroo Island (south-west of Adelaide), and especially in tropical Australia. The soils of these areas are called 'laterite' by Prescott; it should be noted, however, that the word 'laterite' is used in different senses by other writers. The ironstone appears to have been formed by the intensive action of a previous wet and warm climate on the former soil; it has resisted further weathering when exposed to the present climate.

9. Profile = exposure to a depth of 3-4 feet seen in a trench or cutting; the whole of this is used as basis in classification.

The Range and Tableland country of monsoonal Australia. This is naturally barren country, some on account of erosion of slopes, some because of a cover of ironstone, as just mentioned. This classification has been used only where large areas of such country occur.

The Red-Brown Earths have pronounced red tints through the uppermost two feet at least. The surface soil is typically a loam (i.e., neither sandy nor clayey), with clay lying below. Calcium carbonate is common in the deeper subsoil. The existence of this lime shows that these soils, unlike the podzols, have not been severely affected by the rain. The surface soil, however, is of only moderate fertility. The characteristic vegetation is an open savannah woodland with various Eucalypt species in evidence.[10] Even without ring-barking, this savannah woodland possesses a moderate natural grazing value which is still evident in hilly country too dry to cultivate, or too dry for the profitable use of superphosphate for top-dressing the natural pasture. Within this region of red-brown earths are the oldest established wheat areas of Australia, with reliable seasonal rainfall.

The *Mallee* soils are much more alkaline and calcareous than the red-brown earths and are lighter-coloured, pink to light brown being characteristic. As with the red-brown earths, the surface soil has a more open texture than the subsoil and is mostly sand or sandy loam. They occur in the dry margin of the wheat belt and have been only slightly leached, so slightly that salt sometimes occurs in dangerous concentration within three or four feet of the surface. The only element that is seriously deficient in these soils is phosphorus; calcium and potassium are in good supply. These soils in South Australia and Victoria have been derived from wind-blown calcareous material;[11] the landscape consists essentially of alternating sandhills and less sandy flats. The Mallee soils in the eastern states have a natural cover of species of Eucalypt scrub of characteristic form and habit, collectively known as Mallee (Plate 4). In the absence of a more suitable expression, the word Mallee has been adopted for the soils, although their vegetation often comprises larger Eucalypts, especially the Salmon Gum (*E. salmonophloia*) in Western Australia, and other trees including *Callitris* pine species and Belar (*Casuarina lepistophloia*) in the eastern states. Besides their use as wheat areas, extending into climates of very light and erratic rainfall, the Mallee soils near the Murray are used under irrigation for horticultural crops.

Other Soils in Mallee Zone. In the eastern states, the soils lying in the areas marked as 'red-brown earth' and 'Mallee' fit the above descriptions for the most part. In Western Australia, however, the soils in these zones vary widely; the 'normal' soils are mingled in a complex fashion with far less

10. A savannah woodland is a stretch of country, usually flat, on which there are some trees but never enough to give the simple canopy of a woodland (Plate 9).

11. Crocker, R. L., 'Post-Miocene Climatic and Geologic History and Its Significance in Relation to the Genesis of the Major Soil Types of South Australia,' *C.S.I.R. Bulletin* No. 193.

fertile types. These less fertile soils consist of two kinds, namely, sand-plain and ironstone gravels,[12] which together cover the flat-topped ridges which are a major feature of the landscape. These form what is probably one of the most remarkable soil regions in the world. It is associated with the uplifted peneplain formation, which is here dissected into a series of level uplands and valleys with salt lakes, probably representing the lines of drainage of the earlier periods. The better soils of the wheat belt are associated with the Salmon Gum country of the lower levels, while the sand plains are on the upper levels with white and yellow sands and ironstone gravels. The fertility of the sand plain is low compared with the better country, and in some cases such land is excluded from selection.

Other heath country in Australia includes the Ninety Mile Desert of South Australia and the adjacent 'sandhills with heath' and 'little desert' of Victoria. This area, which is in a region of useful winter rainfall, has, nevertheless, not been developed except for grazing, and is characterized by soils of very low fertility, with white or grey sandy surface soils and yellow clay subsoils. In recent months a new attempt has been made on this area using modern knowledge of 'trace element' deficiencies.

Other Pedocals. A 'pedocal' is a soil that contains calcium carbonate in its profile; the term includes practically all soils that have not lost important reserves by leaching. The red-brown earths and Mallee soils are pedocals. The 'others' marked on the map have profiles of uniform texture, usually heavy throughout, with calcium carbonate present at or near the surface and increasing to a maximum in the subsoil. These are mapped by Prescott as 'grey, brown, and black' soils. This zone has the highest average fertility of all; even phosphorus, the most generally deficient of all elements in Australia, reaches a respectable level here in parts of the sub-tropics. Most of it is natural grassland. Much of it is too dry for agriculture, or has too erratic a rainfall; it makes up the bulk of the great pastoral area of Australia, particularly where the rainfall has a summer maximum. In a few places, however, the rainfall is high enough for agriculture. The main region of agricultural land in this zone lies on both sides of the border of New South Wales and Queensland, where the good phosphorus supply, and the ability of the soil to hold water and deliver it to the crop during dry weather, combine to offset the difficulties of an erratic rainfall. The soils of this region come closest to the famous black land or 'chernozem' of Russia and North America, though the Australian soils contain only one-fourth as much organic matter as their overseas analogues.

The various soils of the *desert* need not be considered in detail.

Detail within the Leached Zone. In order to convey a better impression of the varied nature of this most important zone of leached soils, a more detailed map of Victoria is shown in Fig. 26. In this, the main podzolic belt

12. Prescott's 'laterite'.

is seen to include patches of krasnozems (the deep red soils referred to), as well as alluvial strips and islands of volcanic ash, of which the most important are marked. The same podzolic zone also includes small areas of pedocals that are relatively unleached. In the hilly and mountainous country of eastern Victoria, however, the scale is still far too small to show any detail. This country includes the various kinds of leached and stony soils, with some peat on the highest levels, besides numerous valleys, the locations of the largest patches of which are marked with asterisks and are often of high fertility. Our knowledge of the soils of this mountainous country is in any case too meagre for attempting a detailed map.

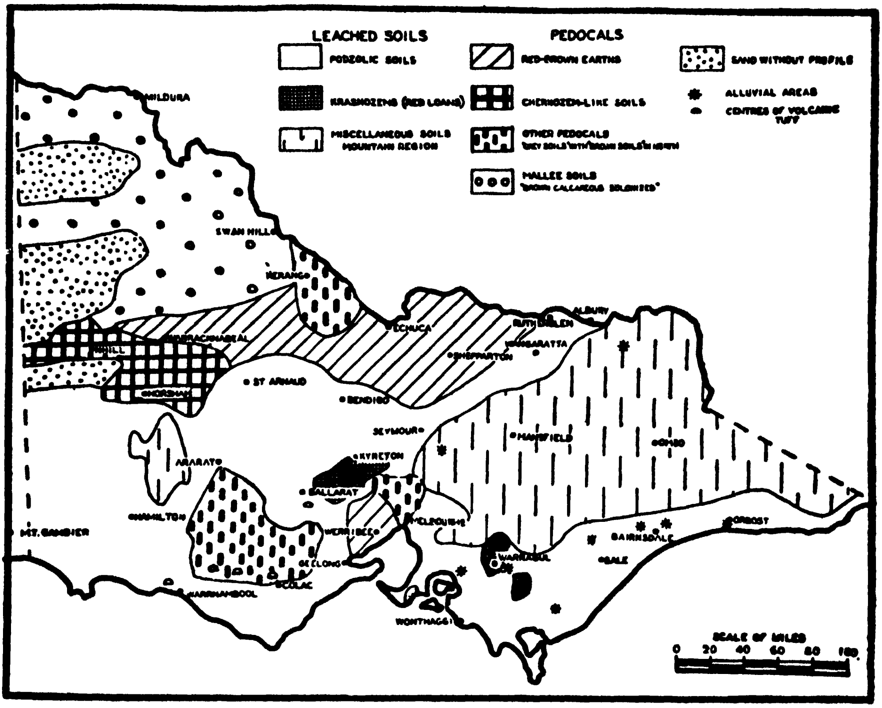


Fig. 26. Soil Map of Victoria

General Review of Soil Fertility in Australia. Looking at the problem broadly, the soils of the districts with most satisfactory rainfall are generally not remarkable for their fertility, river alluviums and some soils from igneous rocks being exceptions. The best soils, on the other hand, are found all too often in districts of inadequate or erratic rainfall. In the southern half of the continent at least, the soil content of total phosphate is usually low, and phosphatic manures are essential. The essential elements, calcium, potassium, and sometimes magnesium, are poorly supplied through the zone of leached

soils. Lime is not widely used as yet, though in a few special areas it has increased production greatly. Potassium is on the verge of deficiency in some areas of high rainfall, including Gippsland, where on some farms the sale of hay can bring on the deficiency in a few years. The wheat belt, however, is fortunate in being well supplied with potassium. The 'trace elements',[13] especially copper and zinc, are also seriously deficient in some of the poor coastal country.

Nitrogen is not normally thought of as part of the natural wealth of the land, since most of the plant's supplies of nitrogen are derived from sources that have been recently fixed from the atmosphere by clovers and other leguminous plants. However, the natural nitrogen reserves of the soil are still being drawn on in some areas, especially on the most favoured chernozem-like soils of the wheat belt, some of which have been alternately cropped and fallowed for forty years or more. It is not known how long such exploitation can persist. Other soil deficiencies are appearing as the scientific approach to the special problems of individual districts develops, or as continuous exploitation depletes the soil of this or that constituent.

It cannot be too strongly emphasized that this broad generalization of soils for such a huge area of country is necessarily inaccurate and misleading if applied in detail. Within each soil region, owing to geological differentiation, the widest variations exist; and the final picture is one of great diversity, with wide but less pronounced variations of natural vegetation. Failure to understand rainfall deficiency and soil variations, and the consequent difficulties in the way of land usage, leads to much undeserved criticism of Australian settlement, as it also was the cause of the failure of many costly experiments in developing Australian systems of farming.

Soil Erosion. Erosion is considered elsewhere in this book under the headings of the various forms of land use. This is a convenient place to review the problem in general. No map exists showing in detail the areas that have suffered serious erosion since settlement.[14] Fig. 27, however, is useful in showing the main areas where serious erosion has occurred. These are (a) the pastoral Inland, which has been eroded by wind (Plate 11), (b) the dry margins of the wheat-belt, the Mallee of South Australia and Victoria, which has also suffered from wind-blowing (Plate 12), and (c) an area with higher rainfall in which destruction by water is widespread, both as sheet erosion and as gullying (Plate 13). This last area is most prominent in the hilly and undulating land on the drier side of the Dividing Range in

13. 'Trace elements' are those that are essential for the health of plants and animals, and which are normally present to the extent of only a few parts per million or per hundred thousand in living tissues. They include copper, zinc, iron, manganese, boron and molybdenum (all of which are needed by plants). and cobalt and iodine (needed by animals). Accounts of important deficiencies of some of these elements, and the method of treatment, are published in the *Journal of Agriculture of Western Australia* (from 1939 onwards).

14. One survey, by Stephens, Herriot, Downs, Langford Smith, Acock, deals with erosion, 'A Soil, Land-Use and Erosion Survey of Part of County Victoria, South Australia,' *C.S.I.R. Bulletin* No. 188.

Victoria and New South Wales, and includes both wheat-growing and stock-raising country. An intermediate area, where land has been less severely eroded, is also shown.

The map is not meant to convey that no areas other than those marked have been seriously eroded. Other areas of wind-blowing exist in pastoral country (e.g., central Queensland and some sections of Western Australia), but in these damage is not so extensive as in those marked.

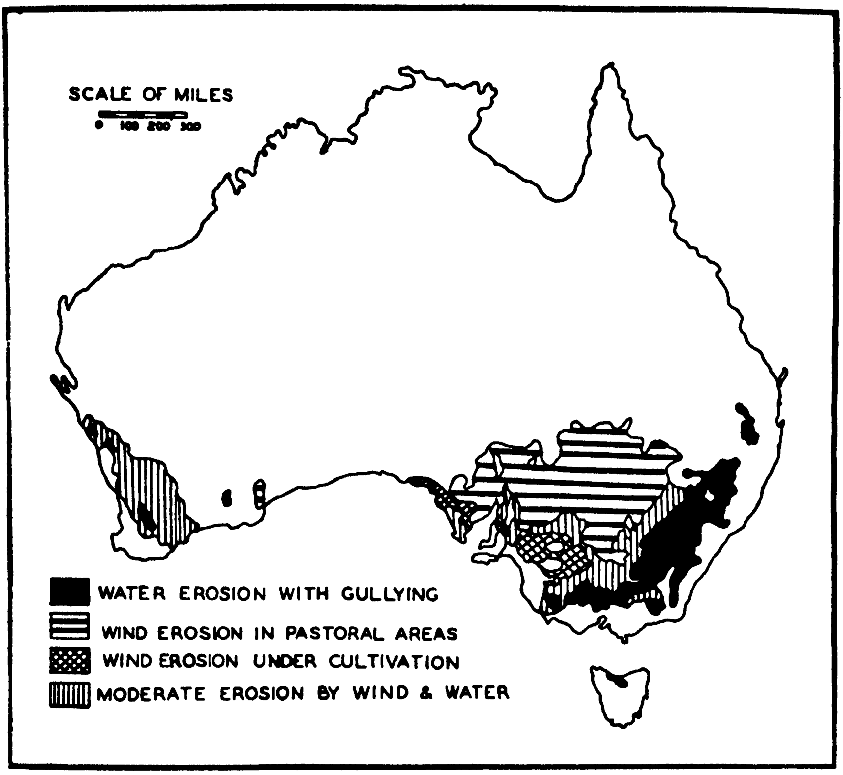


Fig. 27. Areas in which Erosion of Various Types has been reported in serious amount

(From *Conserve Your Soil,* Bank of New South Wales Circular, 2nd edition, 1940.)

4. COSTS OF CLEARING

The task of removing the natural vegetation, so that land may be brought into effective use, is another factor bearing on the question of utilization. The pioneering farmer, be he cultivator, dairyman or orchardist, has to face the problem of replacing the natural vegetation by some more productive type. An extreme case is that of the Strzelecki Ranges mentioned earlier (p. 25 *et seq.*). The pastoralist may be able to use the native species

for grazing purposes in some districts, but where conditions allow intensive utilization and management, he, too, has clearing problems.

Australia presents a wide array of vegetational types, each of which requires special knowledge on the part of the pioneer if he is to make satisfactory progress. The distribution of the natural vegetation types is governed by climate and soil in the usual way. The wettest regions are characterized by 'rain forests'. They are few in number and scattered along the ranges of the eastern seaboard. In the tropics these rain forests (Plate 14) usually contain a high percentage of softwood species, of which the Hoop Pine (*Araucaria Cunninghamii*) is the most valuable, while some others are useful as veneer timbers. Further south the dominant types are light hardwoods. In all these rain forests the vegetation has a dense many-layered canopy, the removal or destruction of which is difficult. As rainfall diminishes, the size of the individual trees and shrubs and the density of the vegetation decline. Wet sclerophyll forest usually has rather larger trees and greater density than sclerophyll forest (Plate 15), while in a savannah woodland the trees are more widely spaced, and the herbaceous vegetation comes into greater prominence. In most cases soil factors exercise a moderating influence, but rainfall is the dominant control.

In general, the dominance of hardwoods (mainly species of Eucalyptus) is a particular disadvantage. Not only is the task of felling the trees arduous, but regeneration from suckers is an additional trouble. Further, many of the species have a remarkable power of retaining a measure of vitality after a fire has passed over them. Subsidiary difficulties, due to the invasion of cleared areas by secondary plants, e.g., bracken, lantana, blackberry, are as awkward in Australia as in other countries.

It is impracticable in a short space to give any complete description either of the necessary variations in procedure or of the costs which are normally encountered. Some attempt has been made to obtain information from farmers and others actually engaged in carrying out clearing operations in a number of districts. A short questionnaire and an explanatory memorandum were drawn up and submitted to farmers who might be accepted as authorities. The enquiry was made in 1933-34, when the price of materials was low, and labour was readily obtainable; the answers received have been used in conjunction with other material in the following consideration of the clearing problem. The cost of fencing and initial ploughing has been discussed in some places, but no item has been inserted for establishment of pasture or crop. The information has been checked by personal inspections in a number of cases.

Mallee Areas. Many areas of Mallee soil (Fig. 24) are covered with a dense scrub of several Eucalypt species which possess the character of forming large tabular masses of tough wood at or just below soil level. The scrub itself varies in height up to about twenty feet; individual stems are seldom

more than four inches in diameter. During the pastoral phase the land was of little value, because the herbaceous constituents of the vegetation were poor, the Mallee foliage was inedible to stock, the cover was so thick that sheep could not be mustered, and water was scarce. The method evolved for converting this area into arable land depended on the use of giant rollers, usually drawn by bullock teams. The rollers smashed the scrub, which was burnt after a period of drying. The contract charge for rolling was usually from 6s. to 10s. per acre, according to the average size of the stems. The success of the whole clearing operation depended on the 'burn'. A steady, hot fire destroyed any rubbish which remained, or shoots which had begun to grow, but if it went too fast, or left areas only partially burnt, the farmer found the subsequent process a lengthy one. After the 'burn' old pieces of roots and sticks were collected into heaps, and poorly-burnt areas were slashed.

The next step was to drill a light crop of long-strawed wheat in the following autumn. With this crop there also grew innumerable suckers from the Mallee roots. If the season was a good one for growth, the following spring saw not only a fairly good yield of wheat, which could be taken off with a comb stripper, but also a heavy crop of straw, which would give a sufficiently fierce fire to kill off the Mallee suckers and weaken the parent plants. If the season was one of light rain, however, the wheat made poor growth, the burn was unsatisfactory, and the Mallee shoots had to be cut by the tedious process of slashing. Three or four yearly burns, together with the damage done to the root systems by cultivating machinery, cleared the ground of shoots effectively. During these years, when good cultivation was impossible, the crops were usually poor, wear and tear on machinery was particularly high, and stock could not be carried. These factors are not readily estimated in terms of money, and their importance varies widely according to the luck of the seasons and the skill of the farmer, but they play a large part in any discussion of clearing costs.

In considering details of costs as they occurred in the inter-war period when much clearing of Mallee was done, an initial 5s. to 15s. per acre would be a reasonable figure for rolling and burning Mallee, and subsequent firing cost from 5s. to 10s. The following summary of low and high cost cases indicates the wide range due to the varying conditions which were encountered.

	Low	High
Rolling	4s.	8s.
Picking up, etc.	1s.	6s.
Cropping and other losses	5s.	15s.
Fencing	5s.	8s.
	15s.	37s.

These estimates include no charge for the land, for water supply and catchments, for interest on capital sunk in land, or for cost of state services.[15]

A variation from this type occurred in those Mallee areas where the scrub consisted of larger plants with stumps over three inches in diameter, or where other species such as Murray Pine (*Callitris robusta*), occurred in quantity. Here the roller could not be used, and the axe was essential until the 'bulldozer' came on the scene. The work was hard, but careful alignment of the cut material ensured that the fire ran well and gave a hot burn, often with very satisfactory results. Under these circumstances, the initial cost of axeing and burning was higher—15s. to 25s. per acre, as against 5s. to 15s. for lighter Mallee, but the shoots gave less trouble. In some Black Mallee areas in South Australia, where the trees were larger, they were grubbed by hand, with the assistance of mechanical devices. The timber here had some value as posts, and the net cost of clearing, apart from fencing, was as high as £4.10.0 per acre. However, the average annual rainfall of this country is sixteen inches, and the soils are more fertile than those generally associated with Mallee vegetation.

Vegetation of Sandy Coastal Soils. Many of the light sands along parts of the coast bear a scrub vegetation of 'yacca', 'black-boy' or grasstree (*Xanthorrhoea* spp.) and other small shrubs, which, like the smaller types of Mallee, can be knocked over by tractor-drawn rollers or heavy chains. It is then largely destroyed by one good burn, and before 1939 15s. per acre would cover the cost of clearing up to the ploughing stage. After clearing, the difficulty is in the establishment of any plants other than low-grade weeds. The only solution is to raise the soil fertility in respect to both phosphate and nitrogen. One cwt. per acre of superphosphate is a minimum dressing for effective establishment of leguminous plants, which, under satisfactory conditions, will gradually raise the nitrogen level, but much larger amounts of superphosphate are necessary before the danger of deficiency has passed; and, in addition, trace elements are often lacking. The cost of clearing, fencing and preparing for the pioneer crop was here of the order of 25s. Again, this did not include provision for water catchments or any of the farm buildings or equipment, and two or three years of manuring and intelligent management are necessary before the grazing reaches an average state of productivity.

In other sandy coastal areas the vegetation comprises a mixed woodland of various species, with the individual trees reaching a height of thirty to forty feet. Here the trees are usually axed and the scrub slashed prior to burning. Some farmers adopt the practice of poisoning the larger trees. This

15. Detailed estimates of the cost of establishment were worked out by the Victorian Agricultural Department, and included in a report by the Development and Migration Commission in 1927, on a proposal to construct a railway from Nowingi to Millewa South, in north-west Victoria, and to carry out other developmental works. (Mimeographed publication by the Govt. Printer, Canberra.)

method requires considerable judgment and skill. A horizontal frill is cut through the bark to the sapwood all round the trunk, at a convenient height, and into this small trough a poisonous arsenical solution is poured. If the appropriate time is chosen, and the sap pressure is low, the poison penetrates both downwards and upwards in the trunk, and the whole tree dies. Under other conditions, only the upper part is killed, and re-growth starts from below. A well-poisoned tree rots in a few months, and can be knocked over. When the scrub has been cut, slashed, dried and burnt, the subsequent operations consist of ploughing with a heavy disc implement, then preparing a rough tilth, and planting a crop of oats with or without subterranean clover as a pioneer legume.

Before 1939 the cost of operations could be estimated as follows:

Poisoning	10s.	per acre
Felling, slashing and burning	30s.	" "
Ploughing	10s.	" "
Fencing	12s. 6d.	" "
	£3 2s. 6d.	" "

Red Gum Savannah Type (Plate 18). The areas of red gum forest which occur in the south-west of Victoria and parts of South Australia present special features of interest. The original vegetation was usually fairly open park land, with two or three large trees to the acre. The timber was valuable, much of this area was cut over by saw-millers, and only those trees which are valueless as timber now remain. The individual tree is spreading in type, the wood is very hard when dry, and, consequently, the tree crowns are a definite problem in themselves. Where the trees are still standing, the normal method of clearing is by ring-barking and then heaping all fallen limbs and bark around the stumps and burning off. This destroys all smaller rubbish, but the main trunks still stand. In 1938, this work could be done by contract on land bearing about two large trees per acre for 20s. to 25s. In an actual instance on land which had been ring-barked twenty years earlier, the clearing of 97 acres required 800 man-hours for tree pulling and 2,280 for cutting, heaping, grubbing and burning—32 man-hours per acre; another area of 12 acres, with lighter timber, required 260 man-hours.

Twelve months after ring-barking and burning off, the land should be sufficiently clear to enable teams to work round the dead trees with cultivating machinery. The old dead trees stand for years, and are gradually removed for firewood. This method of clearing is relatively cheap, and the cost, including fencing, up to the stage of sowing the first crop, was of the order of £2.10.0 to £3 per acre. Where introduction of pasture is desired, special precautions must be taken to avoid the establishment of Red Gum seedlings. The young plants are edible when very young, but their older leaves develop

substances which are unpalatable, and sheep will not touch them. Land liable to bear seedlings must be heavily grazed, otherwise the re-growth which occurs is most troublesome, and requires treatment with mattock and spade. Complete clearing, involving removal of all timber, including roots, is not regarded as an economic method in Red Gum country.

Other Types of Woodland and Forest. These are very varied in the difficulties they present to the pioneer. Usually there are long and short methods of clearing. In the long method the light timber and shrubs are first cleared with the axe. The medium trees are also felled at an early stage with forest devil or other tackle, and the whole is fired. The older trees are ring-barked and left standing, to be removed later when time, aided by bacterial and fungal action, has destroyed all but the main roots (Plate 20).

Wherever forest trees are concerned the nature of the root is all-important. In some species the stump of the dead tree, when fired, burns right down into the soil. In other cases it burns but slowly; and, if the land is to be cultivated, the root system must be dug out or blown up. The Gimlet (*Eucalyptus salubris*), typical of many of the better soils in the wheat belt of Western Australia, and the Blue Gum (*Eucalyptus globulus*) of parts of the Strzelecki dairy country in southern Victoria, are examples of the former type, which, however, is the exception rather than the rule.

Detailed analysis of the method adopted in each type of woodland or forest is unnecessary here. The results of the questionnaire enquiry already referred to have been drawn together in the following table, in which the costs are estimated for various classes of country. These classes have been arranged in ascending order of rainfall rather than geographically.

In general, the costs are higher in the heavier rainfall districts because the forest cover is heavier. The costs shown deal with clearing by the rapid method, and include the preliminary ploughing where the land is to be used for cultivation. In many districts the long method is an alternative, or even the usual practice, but costs are not easily obtained, since the land earns some income while still bearing trees and a good deal of fallen timber, so that it is difficult to separate costs and returns. The length of this intermediate phase varies considerably, and in most cases the scrub vegetation exhibits its strong colonizing powers by continually invading the partially cleared area. This renders periodical slashing an essential, but neither the time nor the cost of such operations are recorded at all accurately.

The figures stated do not include the cost of the land itself, nor expenditure on fencing and general equipment of the property. As regards the former, there is a great variation according to the type of country. Very light land may be as low as 5s. per acre; heavy forest, in which the timber has a potential market value, may in exceptional cases be priced by the Crown as high as £4.

EXAMPLES OF AUSTRALIAN CLEARING COSTS

(Obtained by Questionnaire, 1933-34)

State	District	Av. Annual Rainfall	Original Vegetation	Clearing Cost per Acre	Type of Production Intended
W.A.	Kellerberrin	13″	Salmon Gum, Gimlet, York Gum, Jam	32s.	Wheat (and Sheep)
,,	Bruce Rock	13-15″	Salmon, Gimlet, York, Mallee, Jam	28s. to 40s.	,, ,, ,,
,,	District E. of Narrogin	16-18″	White, Red and York Gum; Jam and Sheoak	34s.	,, ,, ,,
S.A.	Saddleworth (timbered rises on upper Gilbert R.)	20″	Peppermint and White Gum	£3	Wheat or Grazing
,,	Range country near Kingston	25″	Blue and Mountain Gum, and Banksia	£5	Grazing
Tas.	Glen Huon	30″	Stringy Bark	£15-£25	Dairying prior to fruit growing
S.A.	Balhannah (Adelaide Hills)	36″	Stringy Bark, Blue, Red and White Gums	£5-£15	Dairying and Grazing
Vic.	Drouin	40″	Messmate, Black Butt	£15 and upwards	Dairying
S.A.	Meadows	36″	Stringy Bark, Blue and Red Gum	about £10	Dairying, Grazing, Fruit, Potatoes
Tas.	Kettering	36″	Swamp Gum, Stringy Bark, Wattle	£40-£80	Fruit growing
W.A.	Busselton District	32-45″	Jarrah, Red Gum	£20-£25	Dairying, Fruit, Mixed Farming
Tas.	Winnaleah	41″	Stringy Bark, Blackwood and Scrub	£50 and more	Dairying, Grazing, Root Crops
W.A.	Denmark	42″	Karri, Jarrah, Red Gum	£12-£25	Dairying, Root and Fodder Crops, Orchards
Tas.	Scottsdale	46″	Stringy Bark, White Gum, Blackwood	£15-£20	Dairying, Root Crops, Potatoes

This raises the general point of state policy towards forest conservation as opposed to clearing and settlement. In general, the authorities have been in favour of throwing the land open for settlement at a low figure; millions of acres of timber have been destroyed, to the chagrin of the forester, but much of this was inevitable if pastoral and dairying industries were to develop. The extent to which the timber reserves of the country have been unduly depleted in the process is a moot point which time will decide. In the struggle between the authorities controlling forests and those urging the claims of settlement, the latter have at times exploited their successes too far. In some districts land has been cleared on slopes which are so steep that the control of invading scrub and the general problems of management are particularly difficult, while in other areas soil erosion becomes a grave problem.

Use of Heavier Machinery. In recent years very heavy disc ploughs capable of dealing with all the smaller types of vegetation have been developed (Plates 22, 23), and in addition 'bulldozers' have been employed capable of pushing over trees up to 2 ft. 6 in. in diameter. This modern machinery is capable of reducing the labour and the cost of clearing very considerably in some types of country. A report on the cost of operating such units in 1944 on various classes of country in Western Australia suggests that costs of felling the timber alone varied from £4.4.0 per acre to £1.7.0. In the former case the vegetation consisted of dense saplings averaging ten to the square chain with large dead Red Gums up to 3 feet in diameter; in the latter the cover was about fourteen saplings up to 15 inches in diameter per square chain and an average of two dead trees up to 2 feet in diameter per acre (Plate 21). This work was carried out in 1944 at much higher rates of pay than were made in pre-war calculations. Its cost also includes full allowances for the maintenance of the expensive machinery. Comparable clearing operations in the table would have cost from £5 to £12 per acre before the war and would have taken very much longer, thus preventing the settler from early establishment. These new machines seem likely to have a definite place in future farm development, always provided that they are used intelligently; one particular danger lies in the tendency of some operators to disturb the soil layers unnecessarily, thus bringing infertile subsoil up to the surface.

Cost of Other Basic 'Improvements' and Equipment. The cost of fencing and other permanent improvements is a varying factor. In areas suitable for wheat cultivation, fencing may cost only 7s. 6d. per acre, while on dairy farms, where subdivision into small paddocks is highly desirable, it may be £3 per acre, especially where rabbits are troublesome. These figures are based on statements made by responsible farmers, but the natural human desire to claim better results than are actually achieved suggests that they should be accepted with caution.

The cost of providing water supply varies greatly; natural supplies are the exception rather than the rule, and the construction of dams, bores and wells may entail a heavy outlay. The cost of houses and other farm buildings also varies widely. In areas rich in natural timber, log huts are occasionally found, and 'pisé' has sometimes been used. The cost of the erection of such buildings in terms of labour is probably higher than that of rough dwellings of sawn timber and galvanized iron. In the drier areas suitable local timber for housing is often entirely lacking.

5. RELATION OF CLEARING COSTS TO MARKET VALUES OF IMPROVED FARMS

The final result is that before World War II wheat land could be cleared and equipped for farming purposes at an average cost of about £4 per acre, and light grazing country in the better rainfall areas for about the same figure. In heavy forest costs are higher, and the 'all-in' figure was often in the region of £15 to £30 per acre. Even then the land would not have reached a condition of full productivity. The most interesting point lies in the comparison between such costs and the prices of equivalent properties on the open market. Naturally, the latter varies according to the degree of prosperity enjoyed at the time of sale by the type of farming concerned. For instance, during the depression, good 'sheep-to-the-acre' grazing properties were priced as low as £3 to £4 per acre, whereas in times of high wool prices the figure reaches £8-£10. On dairying land, in sound districts, in southern Victoria, values of fertile patches including normal farm equipment have at times reached £100 or more per acre. Under the influence of low butter-fat prices, such values receded to £60 or less. Land of the type which could be cleared for about £25 per acre would fetch £30 to £50, with high prices of butter-fat, and about £20 when prices are low. This implies that there is a relationship between clearing costs and average land values in most districts. During boom periods in the wheat belt some farmers took up new areas, developed them rapidly by very hard work and sold out at a profit after a few years. Often such individuals endeavoured to repeat the process, and some were caught by the depression and the slump in land prices which followed. This picture of costs and variations in land values is illustrative rather than actual. Land prices are notoriously 'sticky', and often do not react to changing conditions except under the most severe pressure.

In most of the better rainfall areas the present semi-cleared sections are situated on poorer soils or in distant spots removed from transport facilities. When clearing costs are added to these disabilities, there is no inducement for men to take up blocks in the expectation of developing an asset with a high market value.

Men who are prepared to capitalize their wages, and the toil and endurance of their families, are able to eke out a bare existence for a more

or less lengthy period, provided that they retain health and strength and are not forced to incur too many liabilities during this stage of primary equipment of their farms. This state of affairs, apparently, exists in most of the pioneer belts of the world.[16]

It is frequently alleged that the materials required by the settler are particularly expensive in Australia. The Royal Commission on the Wheat, Flour and Bread Industries[17], examined the matter somewhat exhaustively and found that, for many articles, the prices charged in Australia are approximately the same as in other countries, plus the costs of freight, exchange and distribution. In other cases there are duties which support the Australian manufacturer. The general conclusion is that the costs of establishment are directly raised, to some extent, by the operation of the tariff. The main outlay in developing new country is, however, the cost of labour, and the effect of the tariff on this item, though undeniable, is difficult to assess. Further, the general effect of the tariff is to depress the value of developed lands, and, consequently, to deter settlement on a speculative basis. This survey of the conditions and costs of developing land in Australia forms the background against which the utilization of land by the individual industries and the possibilities of expanding them as unfolded in the following chapters must be viewed.

16. Bowman, Isaiah, *Pioneer Fringe* (Amer. Geog. Soc. Special Pub., No. 13, 1931).
17. *Second Report,* 1934-35, pp. 119-134 (Govt. Printer, Canberra).

Chapter IV

THE WOOL INDUSTRY—GENERAL CONSIDERATIONS

1. Factors which Limit the Areas Devoted to Sheep
2. Developmental Trends Affecting the Distribution of Sheep
3. Differentiation of Districts as Regards Types of Sheep and Sheep Husbandry

CHAPTER IV

THE WOOL INDUSTRY—GENERAL CONSIDERATIONS

THE history of the wool industry outlined in chapter II shows that progress was by no means uniform. Although there were times when wool-growers made large profits, there were other periods of severe losses and even ruin. The names of those who were successful have been carried down in local history; less is heard of those who staked their all on the hazard of a clip or a station and lost. The cause of failure lay sometimes in the man and his lack of judgment of either land or stock, and sometimes in the luck of the game. Great effort and deserving skill were often defeated by the onslaught of drought, the trial of fire, or the development of some new trouble such as sheep diseases or the plague of rabbits which spread over vast areas in the 'nineties.

But the calamity of drought or pest is not the only worry of the stock-owner; management, too, presents its problems. It is not enough merely to sit and watch the sheep grow and increase in numbers. The management of a modern sheep station may employ a labour force the size of which, in the eyes of an English farmer, would be hopelessly inadequate for the area concerned. Yet as an organization for its particular purpose, and having regard to the system of production in vogue, it is probably extremely efficient.

In view of all the conditions, it is true to say that no other industry throws into such high relief the factors which determine land use in Australia. A careful study of the controls governing wool production will do more to reveal the underlying character of the continent, and the bounds which have been set by nature to the exploitation of resources, than will the examination of any other industry. The aim in this chapter is, therefore, not so much to present a complete survey of the pastoral industry as to discuss, first, the broad controls which climate and topography have set upon its extension, and, secondly, to examine the salient features of sheep management in different areas, having regard to the prevailing conditions. In chapter V an attempt will be made to consider how far more intensive methods may be expected to improve the technique of production and lead to a more intensive use of the areas concerned.

1. FACTORS WHICH LIMIT THE AREAS DEVOTED TO SHEEP

The development of wool-growing has been so great that it is fair to say that sheep farming has been tried wherever the conditions held out any hope of success—and also in a number of places where they gave no such promise. Figures 28 to 33[1] show diagrammatically the present distribution

1. The Northern Territory is excluded, as its sheep population is negligible; in 1947 it contained about 28,000 sheep, principally in the central area around Alice Springs.

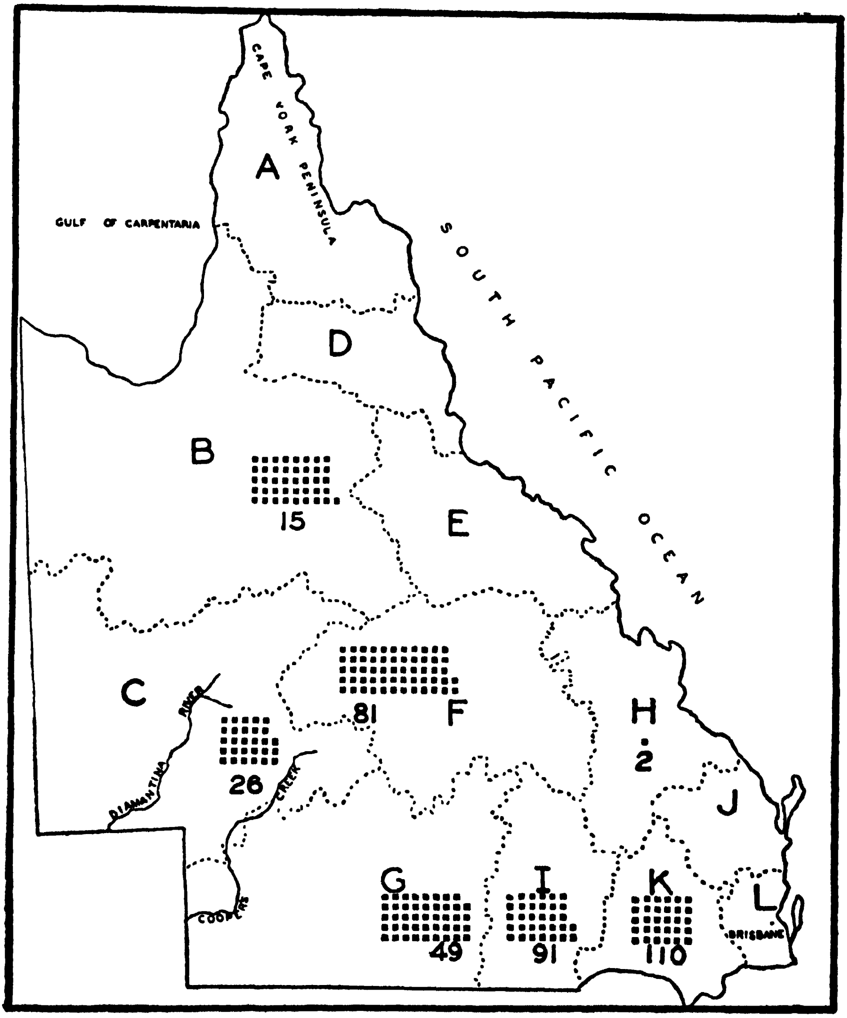


Fig. 28. Distribution of Sheep in statistical regions of Queensland

One square = 100,000 sheep. The position of the groups of squares within each region of the map is not geographically significant in Figs. 28, 29, 30, 31, 32a, and 33.
Figures indicate sheep per square mile
Average 1943-1945

A = Peninsula Division	G = South-Western Division
B = North-Western Division	H = Mackay Division
C = Far Western Division	I = Roma Division
D = Cairns Division	J = Maryborough Division
E = Townsville Division	K = Downs Division
F = Central Western Division	L = Moreton Division

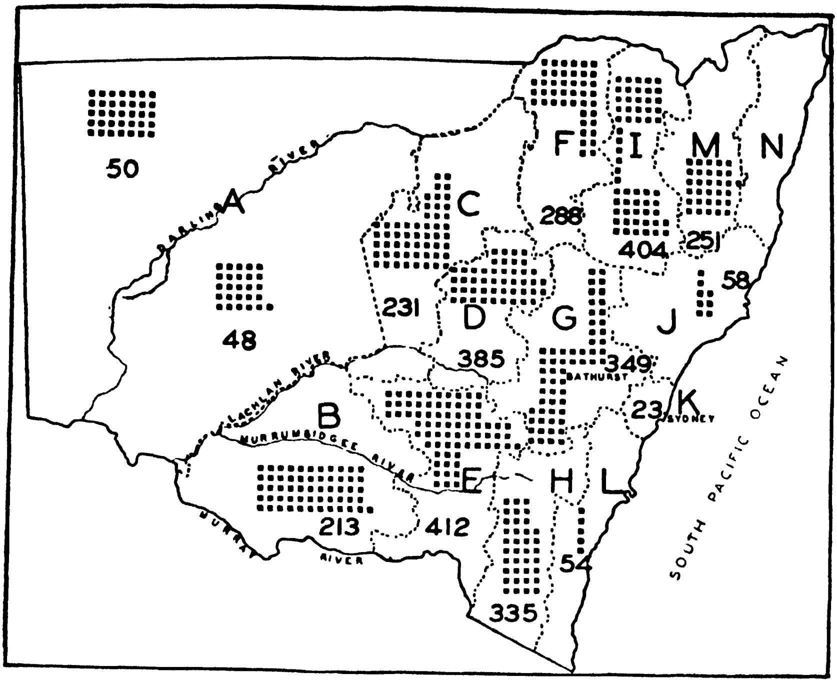


Fig. 29. Distribution of Sheep in statistical regions of New South Wales

One square = 100,000 sheep
Figures indicate sheep per square mile
Average 1943-1945

A = Western Division	H = Southern Tableland
B = Riverina	I = North-Western Slope
C = Central Plain	J = Hunter and Manning
D = Central Western Slope	K = Metropolitan
E = South-Western Slope	L = South Coast
F = North Central Plain	M = Northern Tableland
G = Central Tableland	N = North Coast

of sheep population in all the states. The boundaries of the various statistical regions are shown; in each region the number of the black squares is proportionate to the number of sheep carried, while the figures indicate the sheep population per square mile over the whole district, whether the land is used for other purposes or not. These data are based on the average of the recorded figures for the years 1943 to 1945.

This distribution of flocks is largely the result of experience accumulated over a long period of years. This experience has shown that the areas where failures occur are those where certain conditions are present. These conditions are ruggedness of surface, sparseness of grazing, lack of water, or

excessive rainfall; while regions with particularly high average temperatures are unfavourable to sheep. Each of these factors deserves some discussion.

Topography

The chief areas which are unsuitable for sheep on account of ruggedness are the mountainous regions with steep and usually densely forested slopes. Such regions are characteristic of parts of the whole eastern coastal belt of the continent from Cape York in the north to Wilson's Promontory in the extreme south. In Tasmania the rugged, wet West Coast with its dense scrub has proved too difficult a region for farming of any sort. In these localities the original vegetation was usually dense forest, where the natural conditions left little opportunity for good grazing plants to develop. Further, the rugged nature of many of these areas provides harbour for wild dogs, dingoes and foxes,[2] the natural enemies of sheep. In addition, the high rainfall characteristic of many of these areas renders them specially liable to worm infestation. Cattle-raising provides a more profitable method of utilizing

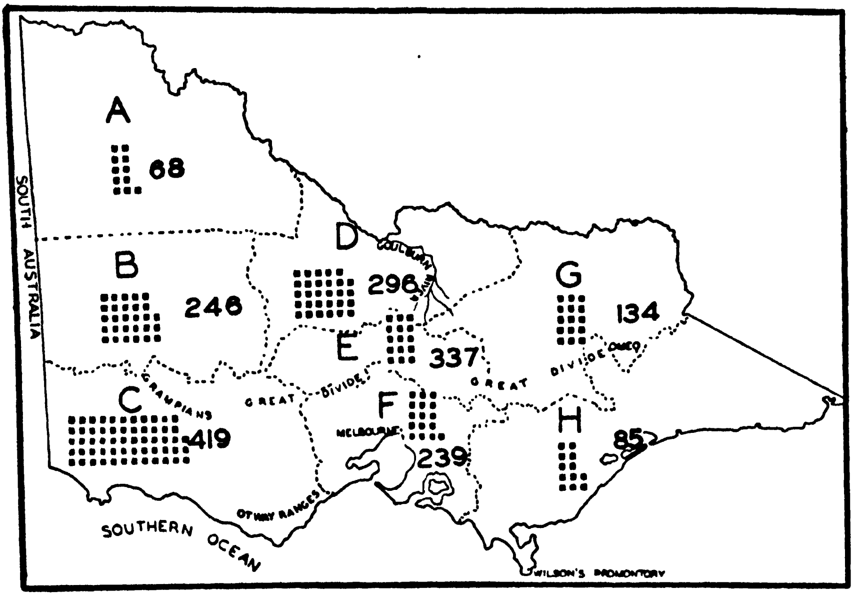


Fig. 30. Distribution of Sheep in statistical regions of Victoria

One square = 100,000 sheep
Figures indicate sheep per square mile
Average 1943-1945

A = Mallee
B = Wimmera
C = Western District
D = Northern District
E = North Central District
F = Central District
G = North-Eastern District
H = Gippsland

2. Foxes were introduced by British settlers.

such country. Mere roughness of the ground, as distinct from mountain ruggedness, is a relatively minor obstacle in districts where the grazing is sound; thus, in the Western District of Victoria, C in Fig. 30, basaltic lava flows with sparse but 'sweet' herbage and a rocky surface are grazed by sheep. On the other hand, in the range country of Queensland, E and parts of F in Fig. 28, where the terrain is also broken but the vegetation is coarse, cattle-raising is the main industry.

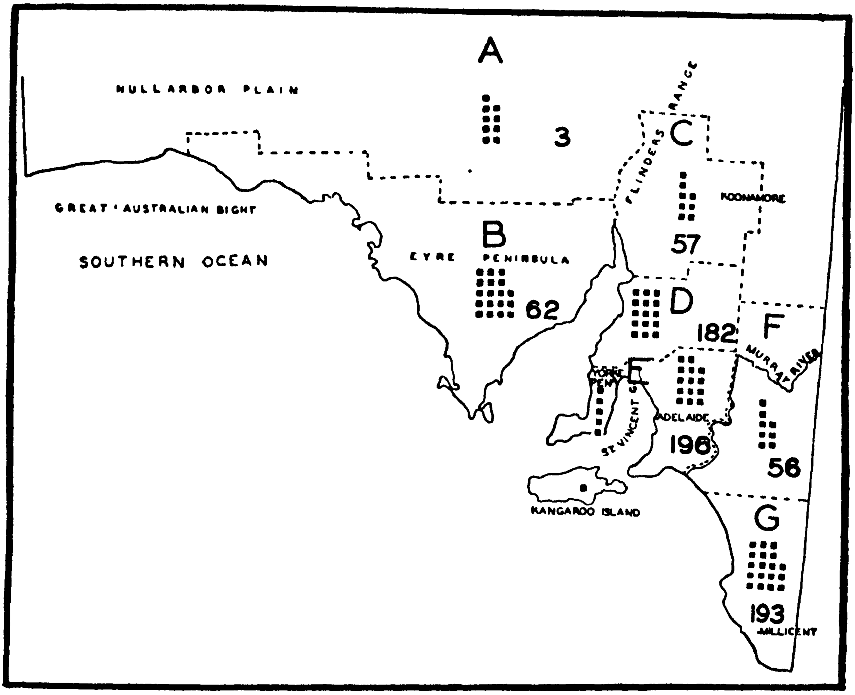


Fig. 31. Distribution of Sheep in statistical regions of South Australia

One square = 100,000 sheep
Figures indicate sheep per square mile
Average 1943-1945

A = Area outside the counties
B = Western Division (portion which is subdivided into counties)
C = Upper North Division
D = Lower North Division
E = Central Division
F = Murray-Mallee Division
G = South-Eastern Division

Sparseness of Grazing

Poverty of the natural herbage as an obstacle to pastoral expansion is encountered in the drier parts of the continent, shown in C and parts of G of Fig. 28; A in Fig. 29; A in Fig. 31; A, E and F in Fig. 32A, where the vegetation is of the desert type. Over wide expanses of sandy country spinifex

is the dominant grass (Plate 19), and many types of this are normally too tough for sheep. In better districts of low rainfall the vegetation is either a desert scrub or a shrub steppe. Either type usually consists of two plant communities growing together—numerous drought-resistant bushes and a wide array of annual herbage plants. Plants of the latter group are very much in evidence after wet weather. Their seeds germinate quickly; the plants grow with great speed under the warm, moist conditions; flowering and seed production follow; and then, unless more rain falls, this annual vegetation dries off. During the whole of this period the sheep concentrate their grazing on this 'herbage' until nothing much is left but a proportion of the seed. The other set of partners in this vegetational complex—the shrubs—is botanically very varied. On some soils succulent plants, such as the 'salt' bushes (Plate 24) or the 'blue' bushes, constitute the main types: on others Acacias, such as Mulga (Plates 34, 35), Gidgee or Myall, may be the dominant vegetation. Generally the sheep only resort to these shrubs when all edible parts of the 'herbage' have disappeared. In these regions rainfall is very spasmodic.

The carrying capacity of such country may be as high as a sheep or more to the acre for a month or two after rain, when the herbage is in good condition. During a dry spell, when the grazing is limited to the shrubs, the carrying capacity gradually falls off. During a drought the shrubs cease growing, and, if it is prolonged, they are gradually eaten down by the sheep. If they are reduced in size to such an extent that they are unable to regain their original bulk after the next rains, deterioration has begun. For wide areas on some types of country bordering the dry centre, the safe carrying capacity does not exceed one sheep to about sixteen acres. If grazing is increased beyond the safe limit, the bushes are gradually reduced in size and number; and, where soils are of a type which is liable to wind erosion, following on the trampling of the sheep, permanent damage may ensue (Plate 25). This has happened in some areas in South Australia and New South Wales, where saltbush country has lost much of its vegetation and the surface soil has been removed by erosion, so that neither saltbush nor mulga can regenerate readily.[3] Economic pressure seems to be the ultimate cause of this permanent damage. Graziers who have expended considerable sums on equipping the runs with bores and fences must either lose this invested capital, which is sometimes borrowed, or run the risks attendant on maintaining an unduly high rate of stocking.

Difficulties of Water Supply

Water supply is, of course, the key factor in the arid areas. In the early days it was a major obstacle wherever catchments were poor and creeks or

3. Ratcliffe, F. N., 'Soil Drift in the Arid Pastoral Areas of South Australia.' *C.S.I.R. Pamphlet* No. 64.

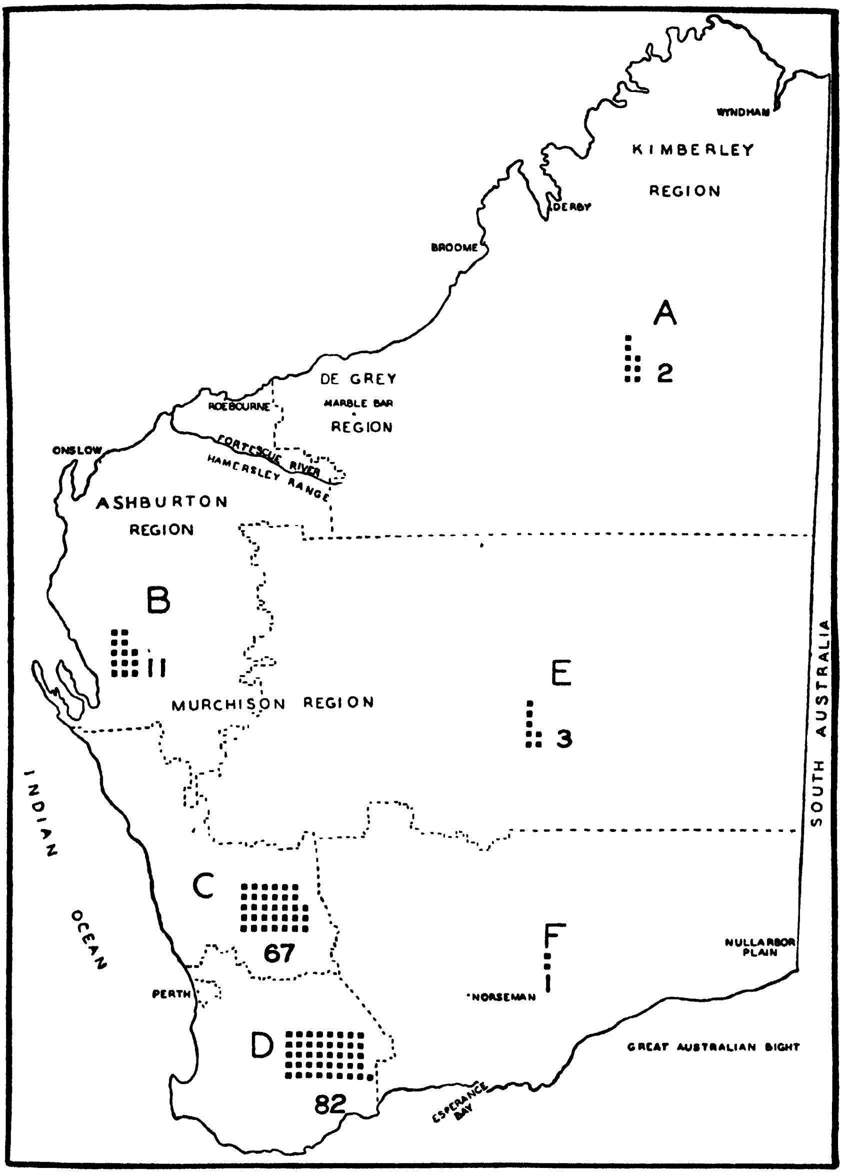


Fig. 32a. Distribution of Sheep in statistical regions of Western Australia

One square = 100,000 sheep
Figures indicate sheep per square mile
Average 1943-1945

A = Northern Division
B = North-Western Division
C = Northern Agricultural Division
D = South-Western Division
E = Northern Goldfields Division
F = Eastern Goldfields Division

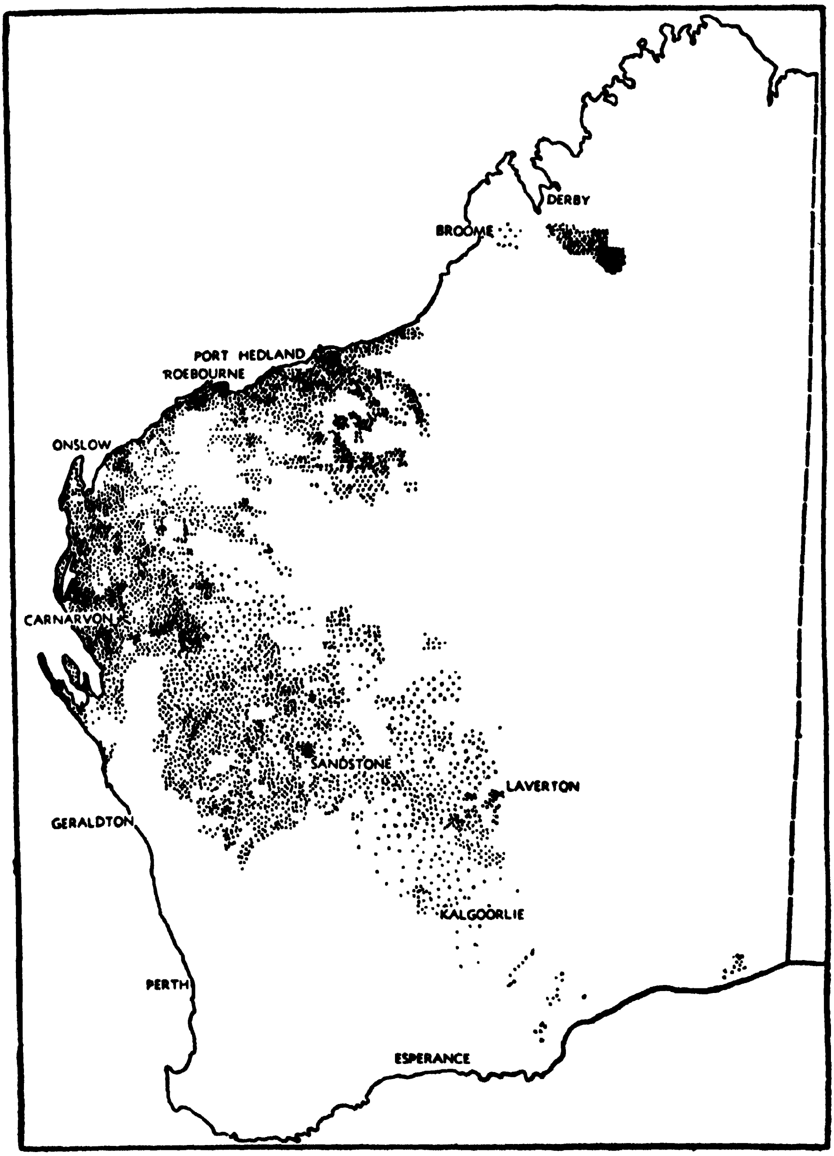


Fig. 32b. Distribution of Sheep in the Pastoral Areas (excluding Northern Agricultural and South-Western Divisions) of Western Australia in 1934, before the drought of 1935-39

(*By courtesy A. M. Stewart, Esq.*)
One dot = 1,000 sheep

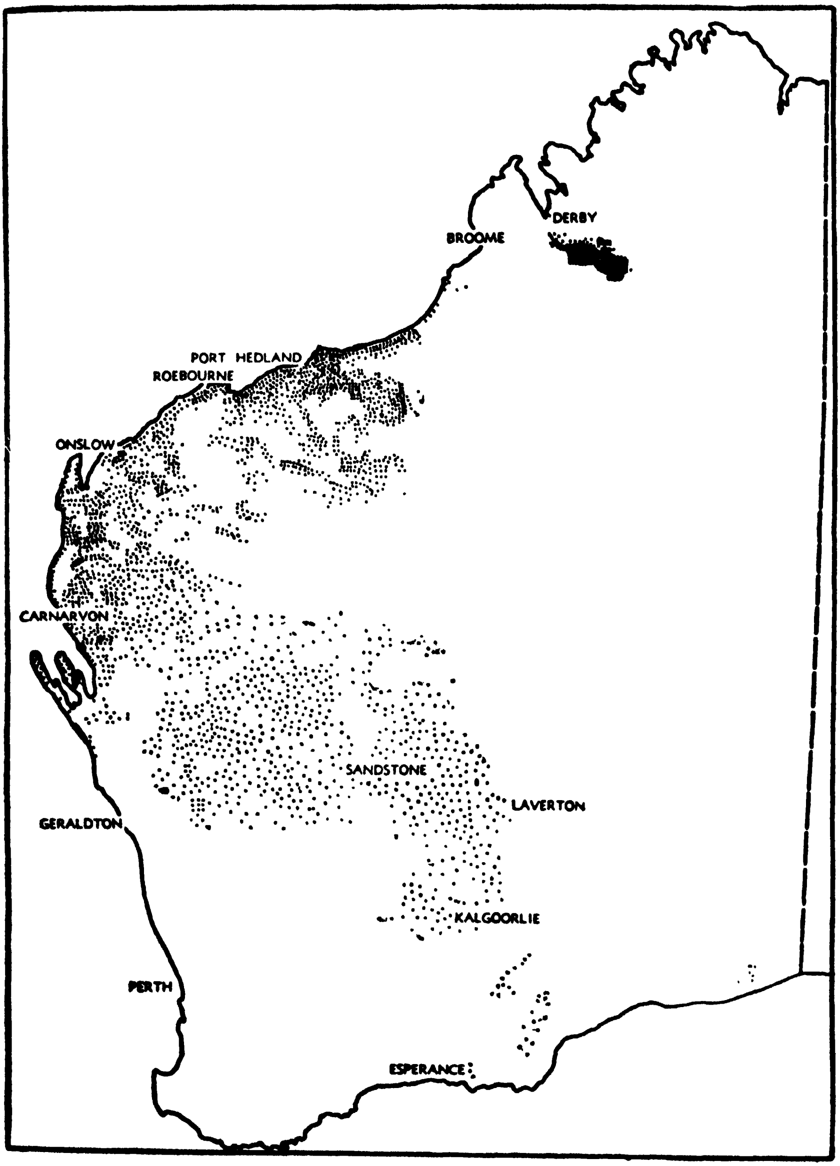


Fig. 32c. (For comparison with the preceding.) Distribution of Sheep in Western Australia in 1937 when the drought had been in progress for two years. The reduction in numbers is most marked in all areas except in the West Kimberleys.

(By courtesy A. M. Stewart, Esq.)

One dot = 1,000 sheep

lagoons absent. However, the development of artesian bores after 1870 altered the position considerably. The whole problem was surveyed in the reports of the Interstate Conferences on Artesian Water, 1912 and 1914, while more recent discussions concerning the changes in the available supply are discussed in a recent Queensland publication.[4] The location of streams and watercourses is shown in Fig. 34, while Fig. 35 shows the artesian basins and the location of bores. The bores vary considerably in depth, the deepest

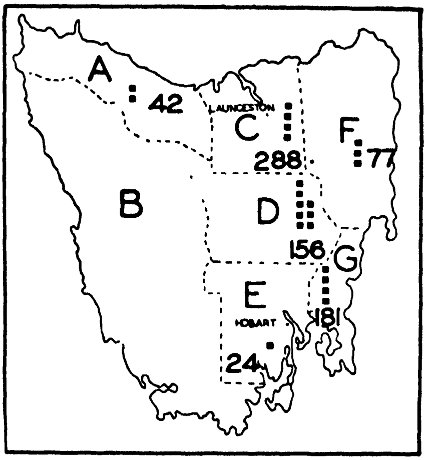


Fig. 33. Distribution of Sheep in statistical regions of Tasmania

One square = 100,000 sheep
Figures indicate sheep per square mile
Average 1943-1945

A = North-West Division
B = Western Division
C = North Midland Division
D = Midland Division
E = South Division
F = North-East Division
G = Eastern Division

recorded being 4851 ft. Some flow freely at the surface, others require the installation of pumps, which are usually driven by windmills (Plate 26). The salinity of the water varies considerably; and while it is usually fit for stock purposes, it is often too high in mineral content for the irrigation of gardens or crops; in some of the areas it is too salty even for stock. In recent years the pressure of water in many bores has decreased and this diminution is said to be greater than can be explained by the gradual corrosion of the bores. It seems likely that a steady flow can be maintained by a more careful use of water. The Queensland Committee estimated the losses from evaporation and soakage to be an average of ten thousand gallons per mile of channel in twenty-four hours.

4. First Interim Report of the Queensland Committee on *Artesian Water Supplies*, 1945 (Govt. Printer, Brisbane).

The provision of water for sheep is relatively easy where the flow from the bores is sufficiently fast to keep the water running in channels for some distance. Where the flow is less generous, and still more where pumps have to be used, the problem is complicated. Sheep need little water when the 'herbage' is plentiful and moist; but in dry times, and especially when the weather is hot, they will not travel more than about three miles from water

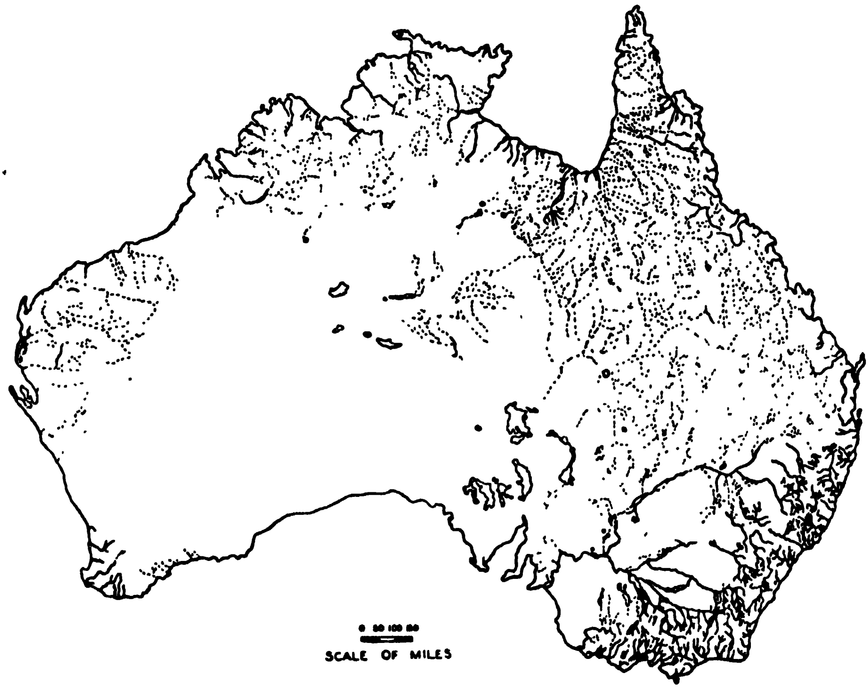


Fig. 34. Permanent and Non-permanent Rivers and Streams of Australia

Continuous lines indicate permanent, broken lines non-permanent, rivers and streams. Based on 'Water resources of Australia' (U.S. Army, 1942.)

in search of food. Consequently, unless there are numerous watering points, the vegetation tends to be seriously over-grazed in some parts of the runs and neglected in others.

High Rainfall

The fourth factor limiting the extension of the sheep industry is high rainfall, which in Australia chiefly occurs in country which is largely mountainous, and almost invariably heavily forested. In many districts the cost of clearing the forest is an obstacle, and even when it has been cleared the herbaceous vegetation is at times too vigorous for effective use by sheep, and

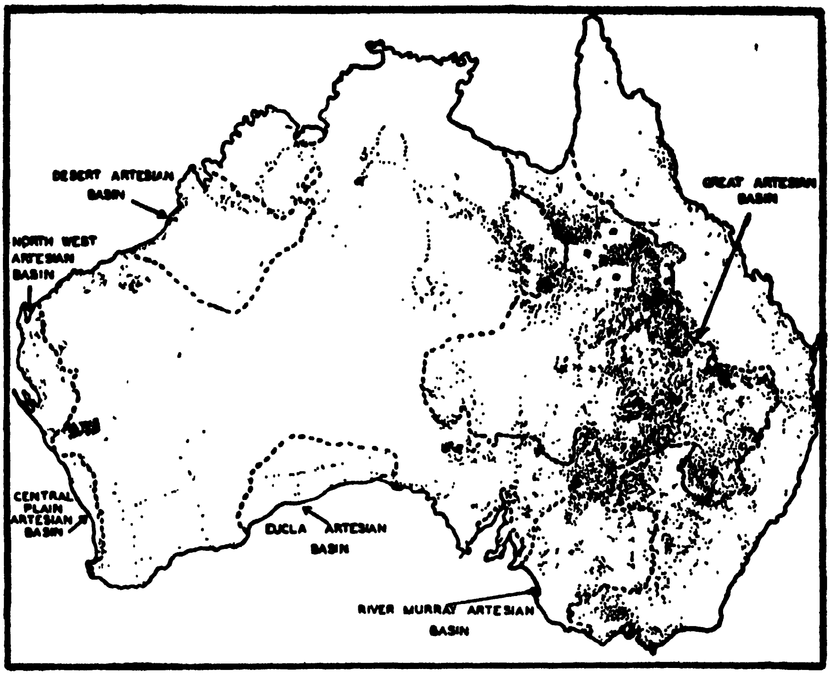


Fig. 35. Artesian Basins of Australia

Broken lines indicate the approximate boundary of the artesian basins. Dots indicate bores, wells, springs, reservoirs, excavated catchment dams. In the N.T., in addition to these, waterholes are also indicated by dots. The large dots show districts where bores are so closely grouped as to make their separate indication unsatisfactory, or where a detailed map was not available.

Based on 'Water Resources of Australia' (U.S. Army, 1942), and on the first interim report of the Queensland committee on the artesian water supplies (1945).

is more suited to cattle. Sometimes sheep are kept on this country, but the difficulty of maintaining them in good health is considerable. The incidence of such troubles as foot-rot and worm parasites is much higher in these areas, and a far more careful system of husbandry is necessary.

Temperature

Temperature is also believed to limit the spread of sheep in the north, but the actual factors lying behind this generalization are uncertain. Much of the country under discussion bears an open vegetation, and, during the rainy season, the growth of herbage is very intense and more suitable for cattle. In some regions, such as those adjacent to the Gulf of Carpentaria, the food value of the material seems to be poor even for cattle; these areas are quite impossible for sheep. In other regions the herbage is more suitable; but at the temperatures which prevail when feed is available, lambs do

not thrive; and, consequently, flocks have to be built up continuously by importations from country farther south.

2. DEVELOPMENTAL TRENDS AFFECTING THE DISTRIBUTION OF SHEEP

Diversion to Other Production

As development has progressed some districts which were once entirely devoted to sheep have been put to other uses. In some areas of better soils, pastures have gradually improved to such an extent that dairy or beef cattle have replaced sheep. Irrigation in districts such as the Goulburn Valley in Victoria or the Murrumbidgee Irrigation Area in New South Wales (Fig. 70) has led to the development of new and intensive types of production in what were once mainly grazing districts.

Such changes are not discernible from an examination of the statistical records of numbers of sheep, both because the changes are inseparable from a general intensification in the areas concerned, and because the additional sheep kept on portion of the area more than compensate for the diversion of some of the country to other uses. For instance, irrigation in a district may raise the sheep-carrying capacity of land from one sheep to two acres to as much as ten sheep to the acre. Therefore, if such a district comes under irrigation, and only five per cent of its area is thereafter used for sheep, there is no decline in the sheep population. Similarly, in the northern parts of Victoria and on the lower of the western slopes of the ranges in New South Wales, considerable areas have been developed for wheat-growing in the last fifty years. The net result has not been a diminution in the number of sheep, because they obtain high-grade feed on the stubbles, and the amount of herbage which appears after cropping is heavier than it would be on unploughed land.

Developments in Areas Devoted to Sheep

When the first pioneers occupied an area for grazing, each settler selected his 'run' on the most suitable land available. The flocks grazed by day and were shepherded at night.[5] Gradually fencing was constructed, paddocks[6] marked off, and equipment installed, thus giving more effective control of the animals and of the pasturage and also avoiding the need for close shepherding.

The rate of clearing varied according to the nature of the vegetation. Natural grass-land areas of 'savannah' type, such as the Bathurst Plains in

5. An interesting account of this phase of pastoral development is to be found in *A Homestead History: The Reminiscences and Letters of Alfred Joyce of Plaistow and Norwood, Port Phillip, 1843-64.* Edited by G. F. James (M.U.P.).

6. In Australia, the term 'paddock' is used to denote an enclosed area of farm land, irrespective of its size, which may be one acre or 100,000 acres.

New South Wales, parts of the Western District of Victoria, or the Darling Downs of Queensland, were especially valuable because they required little or no clearing. Elsewhere, in the better rainfall regions, 'savannah woodland' or other types of light forest were frequent. Here the problem was more difficult, and clearing was slowly carried out over decades; generally the areas which seemed to have better soils were treated first, unless the timber was too dense; later some of the less attractive types were attacked. Instances of this phase of development are still in evidence in many areas, and, as a result, some extra carrying capacity is still being developed in the

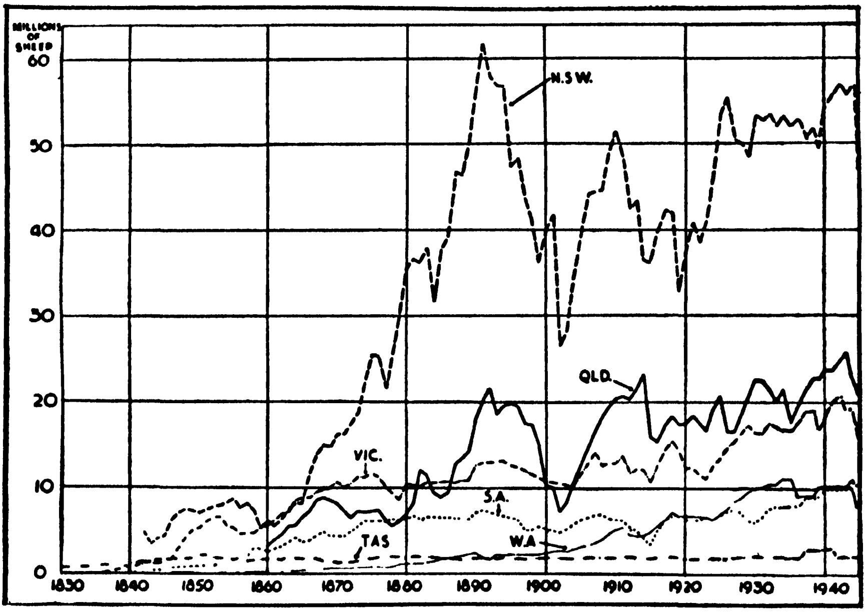


Fig. 36. Growth of Sheep Population by states, 1830 to 1945

regions of better rainfall. Forest areas which might be cleared for sheep runs are now, however, limited to soils which are at best so difficult as to make the success of the enterprise very doubtful.

In areas covered with 'Acacia semi-desert' flora, e.g., parts of C and G of Fig. 28 and of A in Fig. 29, where rainfall is light, and carrying capacity correspondingly low, the amount of clearing which can be done with profit is relatively small. No one can afford to spend much on clearing land which will only support a sheep to three or four acres. In such regions the natural vegetation is usually of the shrubby type, interspersed with herbaceous plants, and this, or at least that part of it which is able to withstand the attacks of the flocks, provides the grazing material.

Decline of Grazing Capacity of Certain of the Drier Areas

Figure 37 shows that in western New South Wales there has been a definite decline in sheep numbers since 1892, while in the rest of the state they are as numerous as at the earlier date. The actual sequence of events during the period is somewhat complicated, and illustrates the interplay of forces which lies behind the utilization of such an area.[7] The wool industry was at a peak of production in the early 'nineties. Thus in 1891 the total number of sheep was 106 millions, a record at that time, and a fact which was, perhaps, symptomatic of the general optimism of the period.

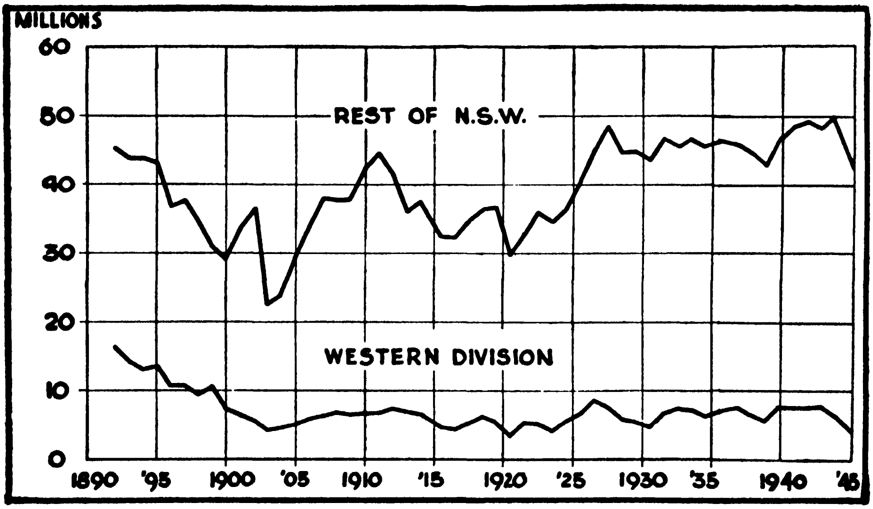


Fig. 37. Sheep Population in N.S.W. Western Division as contrasted with that in the rest of the state

The point of present importance is that, in the areas of less reliable rainfall, the sheep population has never regained the figures which it reached in 1891. Many authorities have declared that the runs were dangerously overstocked at that time; others have blamed the rabbit for the reduction in carrying capacity. The latter contention requires further examination, for, as has been shown (pp. 75 *et seq.*), the character of the grazing material in these drought-liable areas is such that the critical factor limiting sheep numbers is the amount of feed available in the periods of scarcity. At such times the rabbits are fairly easily dealt with on many properties, because they must come to water, and can then be attacked with success. During periods when herbage is plentiful their depredations are not so serious, because there is sufficient feed for both sheep and rabbits. This must not be taken to imply that the rabbit has not been a most troublesome intruder even in the districts

7. See Ruhl, Prof. A., *Das Standortsproblem in der Landwirtschafts Geographie* (Mitler & Sohn).

of better rainfall. The activities of the rabbit have cost the grazing industry many millions of pounds, a sum far in excess of that received for its fur or its meat, and despite the present high price of these commodities they are still a source of expense and trouble. They seem, however, insufficient to explain the decline in carrying capacity in the drier areas since 1891.

The world economic crisis of 1893 had far-reaching results upon primary industries in Australia. Development had been carried out with the aid of large amounts of borrowed capital. The prices of most primary products fell disastrously, and economic uncertainty afflicted every country. The price of wool fell considerably, and did not recover till 1899 (Fig. 38). The general collapse of the financial system in Australia created a most difficult position.

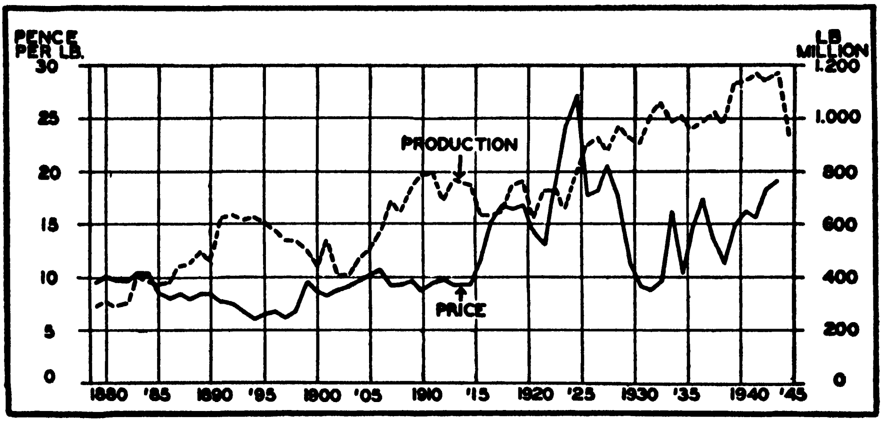


Fig. 38. Australian Greasy Wool Production and Average Annual Prices

The price figures up to 1900 are derived from tables in *An Economic History of Australia*, by Professor E. O. G. Shann of Western Australia. From 1900 the export prices are shown. These figures and the production figures are derived from No. 38 *Production Bulletin* (Commonwealth Bureau of Census and Statistics).

As if these financial troubles alone were not enough, wool-growers encountered serious difficulties on the stations. The seasons 1895-97 and 1899 were very dry, and most parts of the country suffered large stock losses, while 1902 was one of the most severe droughts ever experienced. The rabbit, which had become a pest after 1880, spread rapidly into the outer districts. The combined effects of low prices, rabbits, and drought started a great decline in flocks, which was continued up to 1902. Large tracts of sheep country were abandoned, and in most districts sweeping changes in method and practice were necessary to meet the new situation. Better prices after 1900 promoted a return of confidence, and the industry started to expand once more (Fig. 36), although temporary setbacks occurred owing to droughts in 1914, 1928, 1938 and 1944.

Change in the Character of 'Pastures'

An alternative factor of major significance is probably discernible in the effect of continuous grazing on the plants by the sheep themselves. Unfortunately, there exists no really satisfactory description of the vegetation when the grazier first began to exploit the country. Ecological and grassland studies of the vegetation at present existing have been made,[8] and there is little doubt that they indicate with reasonable accuracy the general type of vegetation which was present in the early days. They are, however, no guide to the proportions of the various species, or to the composition of the vegetation from the standpoint of grazing value.

In the marginal areas it is clear that marked deterioration of the vegetation has taken place. It is known that profound changes have occurred within memory in some districts where scanty rainfall is not an acute problem. Every grazier of experience realizes that animals exercise an influence on the herbage. Some species are gradually suppressed, and others, less attractive to the sheep, are enabled to make greater growth. The plants of the grazing paddock form an ever-changing mosaic of diverse types which are in continuous competition for the available supplies of moisture and plant food. An attractive fodder plant is usually handicapped in competition with its less palatable neighbours. Consequently, where pastures are properly managed, methods must be devised to check the overgrowth of one type and to encourage the other.

The lighter the stocking capacity, the less able is the manager to undertake remedial measures. An example may be cited from the better-class sheep properties in the southern 25-inch rainfall areas, where grazing capacity on the natural unimproved pastures is of the order of one sheep to the acre. Here the native pastures consist of a mixture of short grasses and other small herbaceous plants, among which occur tussocks of tough-leaved species. The sheep graze the herbage, but normally only attack the greener shoots of the tussocks. In drought periods the wiry material of the tussocks will be taken to a small extent; but stock losses may become heavy owing to 'impaction' in the intestines.[9] Unless care is taken the tussocks increase in size and become the dominant feature of the vegetation. The grazier attempts to check this, partly by judicious firing of the tussocks in the autumn, and partly by keeping a few cattle which fail to obtain sufficient material to fill their stomachs from the closely-grazed sheep pasturage and are forced to turn to the tussocks.

8. Prescott, J. A., 'The Soils of Australia in Relation to Vegetation and Climate,' *C.S.I.R. Bulletin* No. 52.

McTaggart, A., 'A Survey of the Pastures of Australia,' *C.S.I.R. Bulletin* No. 99.

Osborn, Wood and Paltridge, *Proc. Linnean Soc. of N.S.W.*, No. 99. Vol. lvi, Part 4, 1931; Vol. lvii, Parts 5 and 6, 1932; Vol. lx, Parts 5 and 6, 1935.

Crocker, R. L., 'Soil and Vegetation Relationships in the Lower South-east of South Australia,' *Trans. Roy. Soc. S.A.*, Vol. 68 (1), 1944.

9. For general discussion of pasture problems see Donald, C. M., *Pastures and Pasture Research* (six lectures delivered in the University of Sydney, 2nd edition, 1946).

These cattle grow slowly, and are not very remunerative, but they perform a useful function.

In other areas, where some of the plant types are poisonous, or have other characteristics which make them inedible, the problem is far more difficult. Stock poisoning is frequent in some areas whenever the ordinary edible herbage has been reduced to a minimum, and the sheep are forced to turn to plants which they normally reject. The best-known case of the spread of an obnoxious plant is that of the Prickly Pear Cactus. After its introduction in the 'eighties this plant spread rapidly in the 20-25-inch rainfall zone in northern New South Wales and Queensland, and in 1916 it was computed that an additional million acres were being colonized by it annually. The story of the detailed study of this aggressive weed, and the introduction of a series of insect parasites to control it, is a long one. The success which has attended these efforts since 1926 is one of the most spectacular achievements of purely scientific work in the interests of the grazier.[10] In other cases, control has proved more difficult or impracticable, and many urgent problems of a similar nature still await solution.

Chemical Aspects of Pasture Deterioration

One aspect of the maintenance of grazing material which is frequently lost sight of by the pastoralist is the depletion of nutrients from the soils on which the pastures are growing. Fortunately, wool itself is relatively low in mineral constituents.

The following table, in part derived from Primrose McConnell,[11] gives the amount in pounds of various pasture nutrients contained in wool and sheep respectively.

Weight in Pounds of Main Constituents of Wool and Sheep

	Per 1000 lbs. of unscoured wool (i.e. from, say, 125 sheep)	One whole sheep 150 lbs. live weight
Nitrogen as N	54·0	11·5
Phosphorus as P_2O_5	0·7	5·3
Potassium as K_2O	56·2	1·7
Calcium as CaO	1·8	1·8
Magnesium as MgO	0·4	0·1
Sulphur	35·5	—

So long as wool alone is being produced, the drain on the nutrient elements is small. When excess sheep are sold off the property, however, the picture becomes a very different one, especially in respect to the phosphorus

10. Dodd, A. P., *Biological Campaign Against Prickly-Pear* (Govt. Printer, Brisbane).
11. McConnell, Primrose, *Note-Book of Agricultural Facts and Figures*, 11th edition, p. 172 (Crosby Lockwood & Son).

supply. It is reasonable to expect that free soil bacteria or those in leguminous root nodules will collect the necessary nitrogen. More attention will be given to this matter later in the chapter; at present all that need be said is that mineral deficiency becomes a cumulative effect in many soils. In southern Australia, where phosphate deficiency in soils is common, continuous grazing on the extensive plan has almost certainly led to a depreciation in the type of herbage owing to the inability of many of the better species to tolerate the low phosphorus status of the soils.

As intensive surveys of grazing and farming areas are made, other soil deficiencies are also becoming recognized. The occurrence of these in the zone of leached soils has already been referred to in chapter III (p. 54). How far similar conditions prevail in the grazing areas with drier climates is not yet known. It is to be expected that they will be less frequent than in moister climates, not only because the lower rainfall implies a smaller tendency for nutrient elements to be washed to lower soil levels beyond the reach of the roots of pasture plants, but also because the rate of stocking is lower.

Looking at the grazing problem in the broadest possible way, it is clear that the 'extensive' system of land utilization can only be a passing phase. In the long run it must slowly lead to degenerative changes in the herbage. Where rainfall is low these changes may be very slow, especially if the soils are fertile. At the other extreme, on high-rainfall country, with poor soils, they may be rapid, and in a few years a property may be 'grazed out'.

In low-rainfall areas, where uncertain seasons render light stocking imperative for economic reasons, the amount which can be spent on maintaining soil fertility, and on pasture management, must be small. For instance, in 12-inch rainfall country, with a carrying capacity of about one sheep to four acres, the cost of improving the pastures in order to raise the carrying capacity fourfold might be met by the increased returns; but, if it will frequently be necessary to hand-feed the sheep for prolonged periods, the problem assumes a different economic aspect. No pasturage will grow without moisture, and there is no evidence that any other country possesses a better grazing flora for low-rainfall conditions than Australia.

3. DIFFERENTIATION OF DISTRICTS AS REGARDS TYPES OF SHEEP AND SHEEP HUSBANDRY

Present Geographical Differentiation of the Sheep Industry

The main development of the industry followed the introduction of the Merino; but, although Australia has large areas of country in which sheep of that type flourish, it would be erroneous to assume that this factor alone had been responsible for the success achieved.[12] The continuous care in

12. See Cox, E. W., *The Evolution of the Australian Merino* (Angus & Robertson) and Austin, H. B., *The Merino, Past, Present and Probable* (Grahame).

selection exercised by the breeders has been an important factor both in the evolution of the animal to its present stage and in the success of the industry. The modern Australian Merino is a far better animal than the types which were originally introduced, and has only been developed as the result of an infinity of experiments by men who have made the subject their life interest. The breed has developed numerous types characteristic of various tracts of country. Presumably these differences are ultimately related through the physiology of the animals to the availability of various nutrients in the natural fodders. Some districts, such as parts of the Riverina of New South Wales, and of South Australia, produce large-framed animals, while other regions, where the feed is relatively poor in certain nutrients, grow small-framed types with specially fine grades of wool.

An interesting point has been as to whether very fine wool is a starvation effect or whether it is possible to grow the finer types of fleece when the nutrition of the animals is adequate. It is clear that a breeder accustomed to the selection of animals on country which was naturally producing fine wool as a result of partial malnutrition might have to change his methods if the vegetation on the property were altered as a result of a policy of soil and pasture management. It may be that failure to adapt practice in culling the flock is responsible for the widely accepted view that fine wool and pasture improvement cannot go hand in hand.[13]

Other breeds of sheep than the Merino have been introduced to Australia since the Cape Fat-tail was brought by Captain Phillip in the early days of settlement. The Merino was so satisfactory for such large areas that it naturally became pre-eminent; but the graziers in moister districts have always been ready to try other breeds which might prove more suitable for their particular class of country. Introductions of stud animals from Britain and elsewhere have been numerous during most phases of development. In the early stages the purpose of such introduction was usually to find, or produce by crossing, a type which would do well on the wetter country, where Merinos become specially liable to foot-rot and other diseases. The development of refrigeration opened a new field of activity for the sheep industry, and, in suitable districts, certain station owners now devote more attention to the carcase.

The character of the country also has an important influence on reproduction. In some districts the flocks have to be continually augmented by the introduction of fresh animals from other regions. In some, periodical losses from drought demand the introduction of fresh sheep; but there are others where the constitution of the animals seems to weaken and their fecundity to decline unless new blood is introduced. This is usually achieved

13. Clunies Ross, Graham, Turner, Carter and Munz, 'The Grazing of Sheep on Improved Pastures; its effect on superfine wool,' suggests that improved pasture does not lead to coarsening of fibre. *C.S.I.R. Pamphlet* No. 71.

(*S.M W.*).

Plate 13. Gully erosion near Charlton, Vic.

The accelerated run off of water from the stony hill, from which this photograph was taken, has caused the development of gullies which are eating their way up the hill.

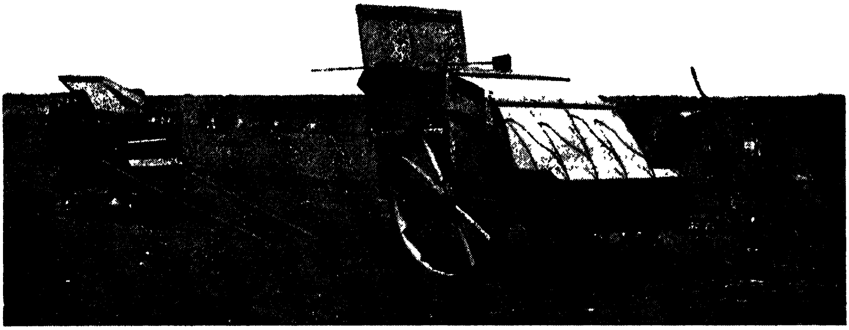
(S.M.W.)

Plate 14. Tropical rain forest, Queensland

A glade cut through tropical rain forest on an eastern slope below the Atherton Tableland.

(*Aust. National Publicity Assn.*)

Plate 15. Sclerophyll rain forest in southern Australia

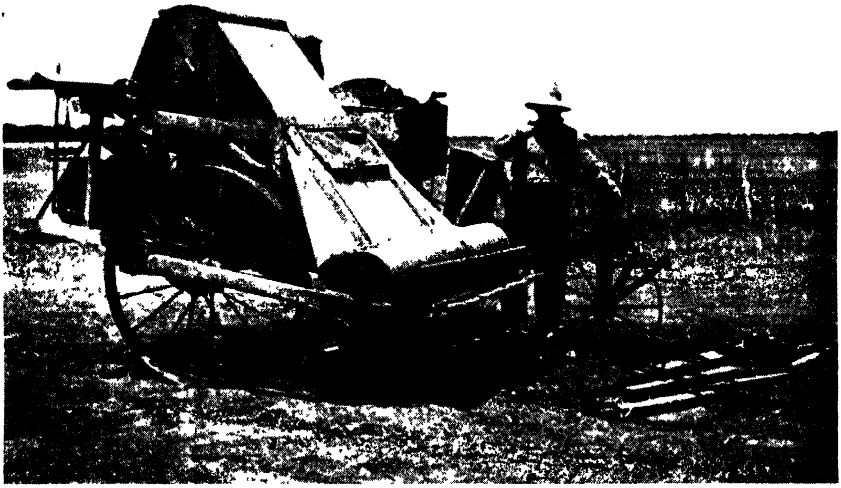


(G. H. Vasey)

Plate 16. Stripper, and winnower

Right. Early form of stripper after J. Ridley's Australian invention of 1843. The ears of wheat are stripped off by a 'comb' and beaters.

Left. Hand-turned winnower. Ears taken from the stripper are passed through the winnower.



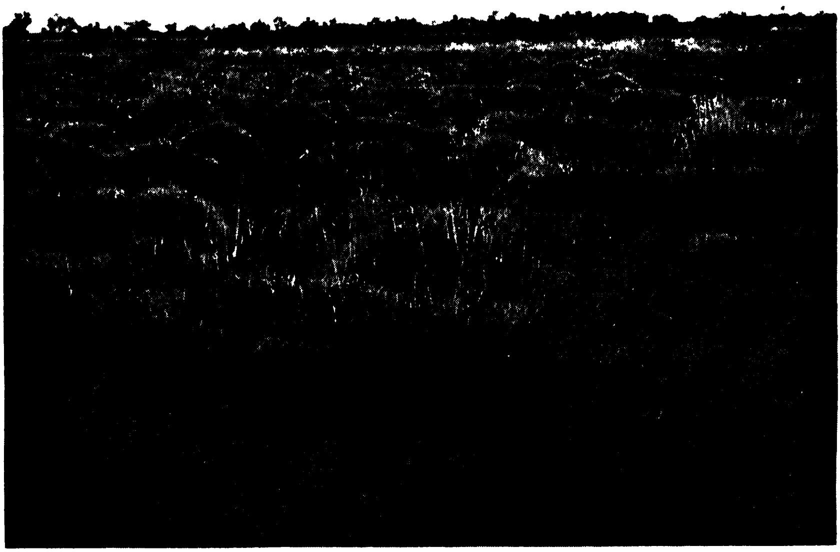
(G. H. Vasey)

Plate 17. Combined stripper-winnower

An early form of the combined stripper-winnower, invented in Australia by H. V. McKay in 1885. This does the stripping and winnowing in one operation. Still in use on types of land which is too rough for the header harvester (see Plate 40).

(Dr. R. T. Patton)

Plate 18. Red Gum savannah, southern Victoria



(A. M. Stewart)

Plate 19. Dry spinifex country (50 miles east of Onslow), W.A.

(*S.M.W.*)

Plate 20. Hardwood forest in the Tweed River area felled for rough grazing and invaded by Paspalum compressum

(*Dept. of Lands and Surveys, W.A.*)

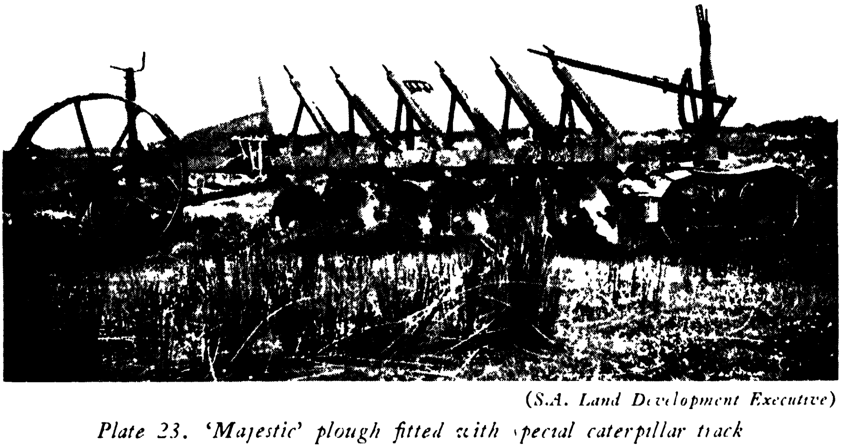
Plate 21. Clearing by bulldozer in Denmark, W.A.

Bulldozer at work thinning and stacking Jarrah and Red Gum preparatory to burning in 'regrowth' country which has been ringbarked.

(*S.A. Land Development Executive*)

Plate 22. Ploughing virgin heath land at Eight Mile Creek, S.A.

Some regrowth was allowed after burning the heath vegetation before ploughing with the 'Majestic' plough



(*S.A. Land Development Executive*)

Plate 23. 'Majestic' plough fitted with special caterpillar track

(*A. M. Stewart*)

Plate 24. Saltbush vegetation in the Murchison Region, W.A.

(*A. M. Stewart*)

Plate 25. The result of drought and overgrazing

Bare land which twelve years ago carried virgin saltbush, N.E. Goldfield Region, W.A.

by bringing in fresh rams from flocks in distant areas. Experience has usually decided which are the most satisfactory types to introduce into any particular flock. Some station owners employ specialist consultants to guide them in making their choice in these matters.

The capacity of stations to rear lambs is very variable.[14] The following table gives the percentage of lambs 'marked' to ewes mated in a series of eleven stations in New South Wales and Queensland, all managed on similar lines throughout the period.

Table Showing Lambing Percentages on a Series of Australian Stations

Station	1931	1932	1933	1934	1935	1936
Queensland						
A	56	28	35	62	30	59
B	52	48	56	50	8	63
C	55	50	56	56	10	53
D	68	60	64	63	6	49
E	71	81	—*	57	42	64
New South Wales						
F	88	101	81	89	74	83
G	61	61	5	62	65	18
H	76	74	52	53	39	67
I	70	74	79	62	74	66
J	77	78	72	49	73	74
K	80	77	85	76	79	81

* No returns

The table shows that on the Queensland stations the lambing percentage is lower than on those in New South Wales. It also shows the effect of the drought year 1935 on the Queensland stations.

On stations where the reproductive rate is high there are two policies open to the management. If circumstances decide that the emphasis on wool production is to be maintained, then the number of wethers is increased; if a ready market is generally available for surplus animals from the station, the proportion of ewes in the flock is increased. The wether yields a larger amount of rather better wool than the ewe, is better able to exist under severe conditions, and requires less attention. Naturally, lambs cannot be effectively raised when seasons are bad; therefore, the drier districts of erratic rainfall usually have a lower percentage of ewes; on the other hand, graziers in the areas of better rainfall, especially where herbage is of a high grade, can expect to derive profit by providing the market with the necessary

14. For general discussions on fertility of sheep, see Kelly, R. B., in *C.S.I.R. Bulletin* No. 112; Gunn, R. M. C., *C.S.I.R. Bulletin* No. 94; and Gunn, Sanders, Granger, *C.S.I.R. Bulletin* No. 148.

supplies of fresh stock. Naturally, the areas from which sheep are drawn to supply the meat markets are found in the districts in which feed is abundant and reliable, at least during the part of the year in which the lamb supplies are expected to come forward.

Fig. 39 has been drawn up to indicate the complex 'flow' of lambs and sheep between and from the various types of sheep properties. Superimposed on the normal traffic thus indicated, there is the constant ebb and flow of live stock depending on seasonal conditions and markets, which all combine

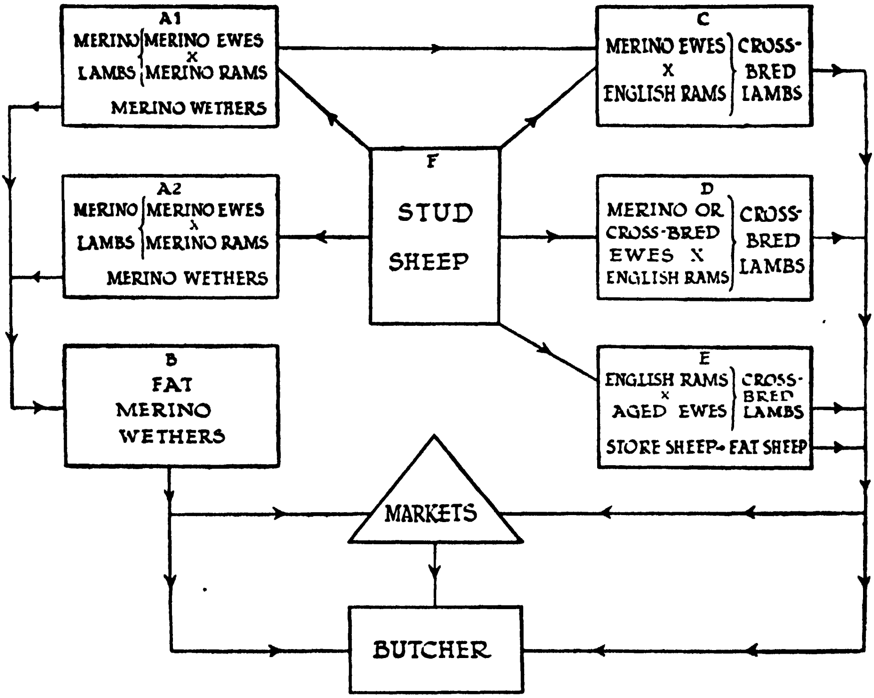


Fig. 39. Diagram of Sheep Flow

This shows the movement of sheep between and from typical sheep properties.

to make the great network of live stock marketing stretching across the Commonwealth—a vital element in the functioning of the industry.

Stations of type A1 are typical of most of the Merino sheep belt; apart from wool, they produce a certain number of surplus sheep. Old wethers are sold to type B, old and cull ewes to C, while lambs are usually not sold. Stations in type A2 are situated in marginal country where lambing percentages are low, and in many seasons losses are severe. Any surplus wethers are sold to B. The A2 type and some of the A1 type purchase rams to maintain the condition of the flock and its fleece. Type B is situated in country suitable for fattening, but not for breeding (owing mainly to the

ravages of diseases and pests). Type C is in wheat-growing country, where Merino ewes from A type stations are mated with rams of English breeds for the production of crossbred fat lambs. Type D is in country with reliable rainfall where wheat is not grown, and where circumstances are suitable for lamb-raising. Here crossbred ewes are often favoured, being mated with rams from English breeds, because the lambs are quicker in maturing and are

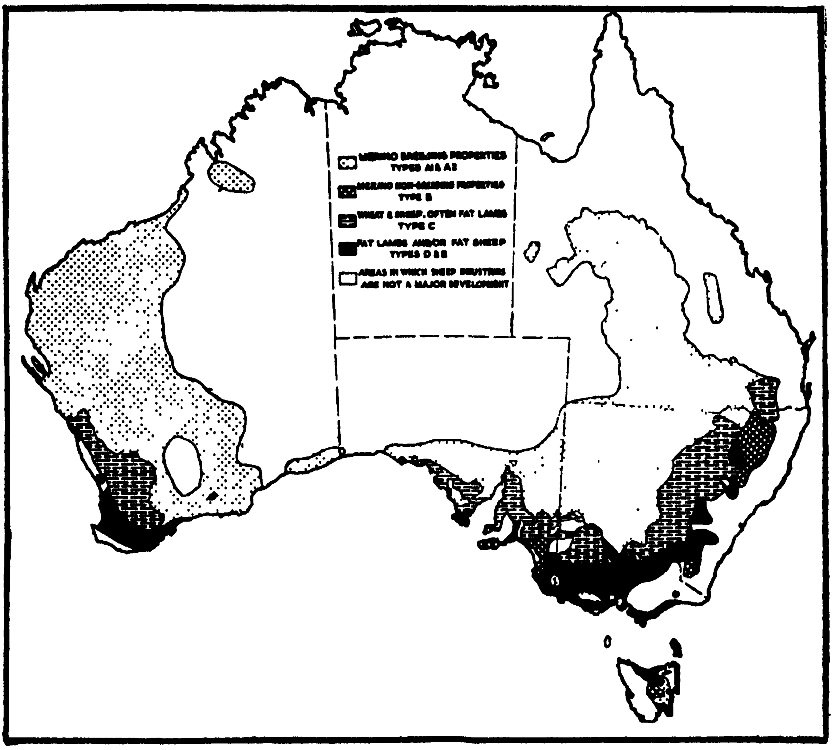


Fig. 40. Distribution of Sheep Types

The authors are greatly indebted to K. Niall, Esq., for much of the information used in the construction of this map.

of better conformation. Both C and D usually obtain a fair proportion of their income from the sale of wool. Finally, type E contains those which are mostly concerned with fattening sheep or lambs purchased in backward condition from other properties unable to fatten them. Farmers in class E usually run small flocks of their own; their farms are situated either in irrigation areas or in rich grazing country. The linked factors of soil type, pasture type and climate all combine to decide the most appropriate use to which any area can be put. There is nothing haphazard about the objective

of the management of the properties. Occasionally pasture improvement or an alteration in management may make a new line of activity possible on a farm, and sometimes farmers gamble too much against the season in trying to attempt a higher grade of production than their farms permit; but such ventures seldom go on for long.

Fig. 40 indicates the way in which the sheep areas of Australia are divided between these types. The boundaries of the sheep regions are naturally not as sharp as shown on the map. It is not practicable to differentiate between the areas occupied, nor is it to be assumed that the sheep and wheat farm area (type C) is wholly occupied by wheat farms, for, as will appear in the next chapter, this particular belt contains many soil types which are wholly devoted to sheep farming of classes A1 or D. Similarly, the zone of type D includes many farms and stations of the A1 type. Properties belonging to the fattening group (class E) are situated in small districts widely distributed in the class D area, and are not specially shown on the map.

CHAPTER V

LAND UTILIZATION BY THE WOOL INDUSTRY

1. Possibility of Extending the Present Sheep Areas
   (a) Marginal Inland Country
   (b) Marginal Country in Wetter Districts
2. Effectiveness of Usage in Purely Pastoral Areas
3. Sheep on Wheat Farms
4. Non-breeding Wool Districts
5. Sheep-fattening Areas
6. Sheep Maladies and Diseases

CHAPTER V

LAND UTILIZATION BY THE WOOL INDUSTRY

THE effectiveness of the utilization of land by the sheep industry must be examined in the light of three main considerations, viz.: (i) the extent to which all available land suitable for sheep has been so used; (ii) the extent to which the present use of the sheep areas is effective as far as sheep are concerned; (iii) the extent to which sheep areas could sustain a more varied type of land use. These problems can only be decided by referring to the rainfall of various areas in the Commonwealth, and Fig. 41 has been constructed with the idea of facilitating such reference. On the map the rainfall experienced month by month over a period of ten years has been set out in diagrammatic form for twenty localities. These localities have been selected because they represent fairly diverse types of country, some of which are carrying sheep, and some of which are beyond the limits of the belt.

1. POSSIBILITY OF EXTENDING THE PRESENT SHEEP AREAS

(a) MARGINAL INLAND COUNTRY (Figs. 32, 41)

This question has already been partly answered (pp. 75 *et seq.*). It is certain that in many districts the sheep industry has pushed too far into the dry interior. The carrying capacity of this marginal country has been reduced by over-grazing; wind erosion is already a menace on certain soil types (Fig. 27). The data for Charlotte Waters (average annual rainfall 5·12 inches) need little comment. Rainfall as exiguous as that shown on the chart is virtually that of a desert. Such country at best is only of value during periods following the irregularly occurring thunderstorms. Broken Hill (9·31 inches) and Tarcoola (6·70 inches) are also in marginal country where there is no regularity about the rainfall, and any system of grazing must be on a lenient basis. Nevertheless, most of the country around Broken Hill is occupied by sheep stations, and some occur near Tarcoola. Eucla, on the shores of the Australian Bight, has an average precipitation of 9·99 inches, but the rainfall of the hinterland is somewhat lower. Here lies the Nullarbor Plain, where considerable expenditure has been incurred for water supplies, with the intention of using the country for grazing sheep on the steppe vegetation.

Tennant's Creek (14·21 inches), on the Adelaide-Darwin route, shows the definite summer incidence characteristic of rainfall in the northern part of the continent. Here the country is too rough and the district too remote for anything better than a few cattle. Katherine (37·68 inches) and Georgetown (31·61 inches) are localities in which the rainfall is higher, but its summer incidence is very marked. Hall's Creek (19·78 inches) is on the

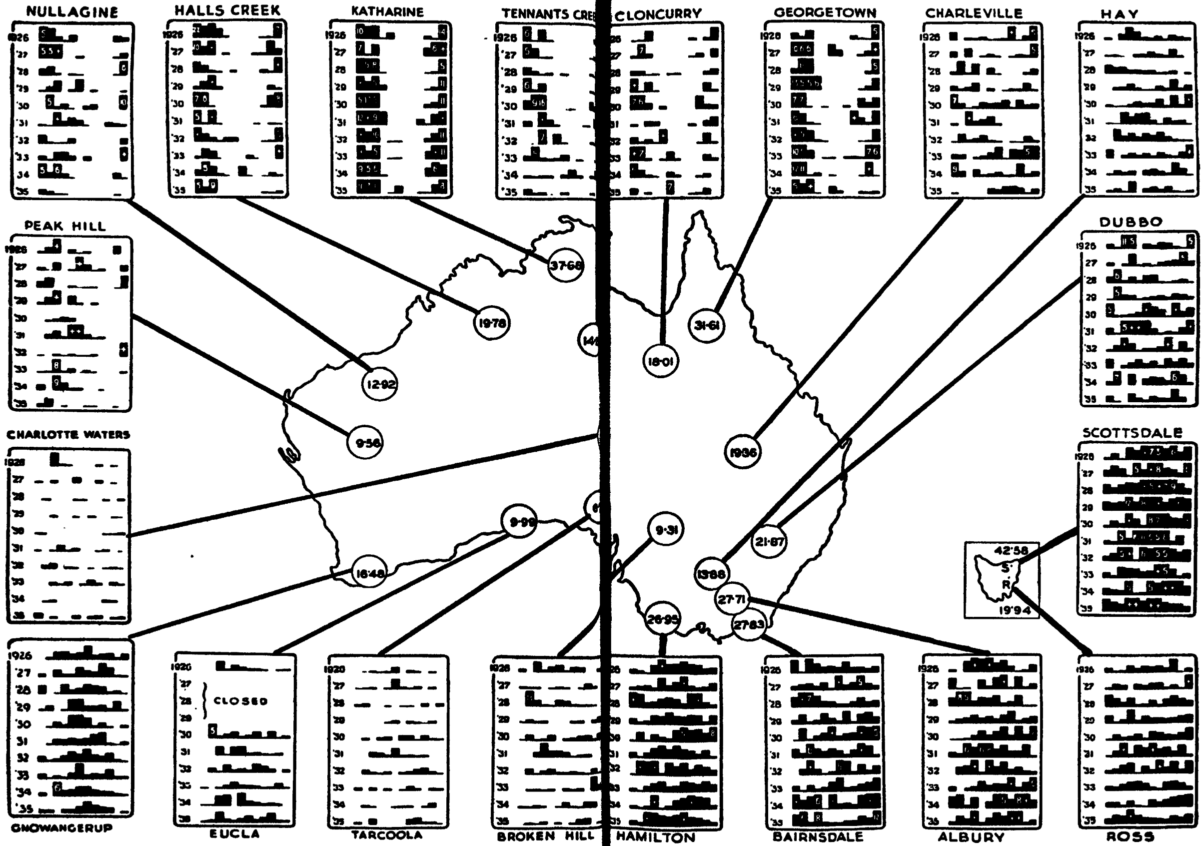


Fig. 41. Monthly Rainfall over a [illegible]*ear period for 20 pastoral locations*

The black vertical columns represent the rainfall for individual months from 1926 to 19[illegible] rainfall of over 4 inches in any one month is shown as 4 inches, and a white cross indicates a rainfall of over 4 but under 5 inches. A rainfall of 5 inches or over in an[illegible] month is indicated by the white figures. Figures in circles indicate average of recorded annual rainfall in inches [illegible]ese locations up to 1938.

southern margin of the Kimberley region, in a district which is traditionally devoted to cattle-raising. The sheep industry is expanding slowly in these parts, owing to the unprofitability of cattle.

At Nullagine (12·92 inches), in the dry part of the north of Western Australia, the summer distribution of rainfall is erratic and evaporation is high. The district carries some sheep, and carrying capacity is influenced by the proximity of the Hammersley Range and of the swamp-lands of the Fortescue River. Peak Hill (9·56 inches) is on the border of the sheep country and is comparable with Cloncurry (18·01 inches) on the eastern side of the continent. In the latter region, in many years, the period between satisfactory rains is long, while the unreliability of effective falls in the spring is a point of special importance, and emphasizes the danger of considering the single factor of annual rainfall alone. An inch of rain in the spring months, when temperatures are not particularly high, starts a very satisfactory growth amongst the 'herbage', and, if the soil is warm enough, the summer-growing grasses will also burst into activity. On the other hand, an inch of rain in January or February, after a dry spring, may, on certain soils, be evaporated so rapidly that it will have little or no effect on wide areas of the country, although plants growing in depressions and along watercourses may benefit. Charleville (19·36 inches), which is farther to the south, shows a rather better distribution, although, as the chart shows, there have been seasons in which the rainfall for five or six months has been negligible.

With the exception of some of the Kimberley country, there is no evidence that any of the dry areas which could be used for sheep have not been thoroughly exploited already. The fact is that the hazards accepted have often been too great.[1]

The history of the marginal dry country contains innumerable instances of financial disaster.[2] Some day an attempt may be made to ascertain whether, over a long period, the expenditure made on areas of this type has ever been subsequently recouped. Individuals may have made money when seasons were good and prices high, but their successors have often lost all in the venture. It is conceivable that wrong methods have been used and that the patchy nature of the rainfall demands a corresponding adjustment of grazing methods. Possibly a nomadic system of occupation and management over vast areas is required. This system was adopted by Sir Sidney Kidman with cattle,[3] but the obstacle to such procedure with sheep would lie in the greater difficulty of moving them over long distances.

In all the localities so far discussed there is no possibility of improving

1. *Board of Inquiry Report*, 'Land and Land Industries in the Northern Territory of Australia.' This Report suggests that 2·5 million sheep could be carried in selected areas of the Northern Territory, provided that tariff and other burdens were alleviated, and additional railways (presumably unremunerative) were constructed. (Govt. Printer, Canberra.)

2. See Roberts, S. H., *History of Australian Land Settlement*, pages 170-1 (M.U.P.). See also *The Squatting Age*, by the same author, pages 384-5 (M.U.P.).

3. See Idriess, I., *The Cattle King* (Angus & Robertson).

the pasturage except by careful management of the grazing. The carrying capacity per square mile is too low to warrant any large capital expenditure.

(b) Marginal Country in Wetter Districts

In considering whether all available land has been used, some note must be taken of districts in the wetter areas, where there are large tracts of country with poor soil and low-grade forest or heath cover. Some of these are in districts with climatic conditions suitable for sheep. Past attempts at clearing this country have mostly failed, either because the cost of clearing the bush and developing the necessary improvements is too great, or because, when cleared, the soil is so poor that effective pastures cannot be easily established. The costs of clearing in such districts have already been mentioned (pp. 59 *et seq.*). The total outlay in establishing a farm with buildings and water supply, in addition to its pasturage, is seldom less than £4 to £6 per acre. A good deal of clearing has been done in localities of this type, but it is doubtful whether many properties have been developed satisfactorily in the economic sense. Before 1940 such country could often be bought, in a cleared state and with adequate improvements, for less than £6 per acre; and, as there were young men anxious to go on the land, and no dearth of capital to finance sound agricultural or pastoral propositions, the inference must be that even this price was too high.

On the lighter soils the clearing costs may be definitely lower, but the difficulty in the past has been to establish a type of pasturage which has a good carrying capacity. An interesting case is to be found on Kangaroo Island, South Australia (Fig. 31), which was one of the first areas on which settlement was attempted. It is roughly a million acres in extent, and has a mild climate, with a rainfall of about twenty-three inches, well distributed except in the summer. Past settlement has been mainly confined to small areas of rather better soil at the eastern end, and to certain creeks along the coast; but the rest of the country has defied attempts at utilization. The natural vegetation consists of a dense bush, with few trees (Plate 27), which can be broken down by a large roller drawn by a tractor. A single burn destroys the rubbish and most of the plants, and one or two ploughings complete the process. As there are no rabbits on the island, fencing requires no special adaptation. Given average luck and care in timing the burn, the whole process of development can be achieved for less than £3-£4 per acre.

Past experience, however, has been that the herbage which appeared was very poor in quality, consisting mostly of weeds, low in nutritive value, and short in growth; in fact, the soils were too poor in nutrients to support effective plants. The addition of phosphatic manures failed to lead to the establishment of clovers except on farms which had been cleared for years. In recent years the use of clover seed inoculated with special strains of nitrogen-fixing organisms and the discovery of a copper deficiency have led

to greater success. The new venture is of special interest, as somewhat similar soils are abundant in several coastal districts of the mainland.

Over all these districts the problem varies somewhat from place to place. Occasionally the bush is denser and clearing costs are higher, sometimes there is a drainage problem, and rabbits are usually troublesome. Ultimately, however, the question is one of learning how to establish an effective pasturage, and, having established it, how to maintain soil fertility. It is certain that no easy road to wealth lies before those who undertake the risk. Frequent applications of phosphate, and probably occasional dressings of potassic fertilizers as well, will be necessary, while a continual watch on plants or animals for signs of 'trace element' deficiencies as they occur will be essential. Consequently, the costs of maintaining fertility will be fairly high when compared with those of other grazing areas, while cropping will rarely be possible. A period of depressed prices for commodities, without proportionate reductions in the cost of essential fertilizers, would cause financial difficulty.

Agriculturally the problem is similar to that of the development of farming on the areas of poor sandy soil in northern Europe; but the lower price levels obtainable for produce make a similar development less easy of attainment in Australia. Climatically there are wide differences between the types, the milder winters in Australia to some extent offsetting the dry summers. It is certain that the Australian experiment can only be successful when methods suitable for the locality have been worked out, and the correct equipment of plants necessary for those methods have been obtained. How far progress has been made in this direction will be discussed when dealing with the intensification of grazing.

The answer to the first question, therefore, is that in the dry parts of the continent further development of land for sheep would generally be unsound, while, in the wetter areas, it is difficult unless new discoveries reveal methods which would both lower the cost and increase the certainty of the result.

2. EFFECTIVENESS OF USAGE IN PURELY PASTORAL AREAS

The second question concerns the extent to which the present areas devoted to grazing are effectively used. The answer can at best be only an approximation, because the local conditions vary enormously from station to station. The main factors for any locality are, first, the extent to which it would be economically practicable to introduce grazing plants which would be more effective than those at present existing; and, second, the extent to which the areas could be more advantageously used if a different system of husbandry were adopted, under which more, or better, sheep could run, providing greater care were taken in regard to their nutrition and general management. The general character and vagaries of the climate are important in connection with both inquiries, while the natural vegetation is the immediate factor governing carrying capacity and system of management.

We proceed, therefore, to examine the sheep lands, district by district, in order to reveal their peculiarities and possibilities.

The Sheep Areas of Queensland and Western New South Wales (Figs. 28, 29, 40)

Fig. 40 shows that a large area of the sheep belt is occupied by stations which are essentially wool properties, but expect to produce enough young stock to maintain their own numbers and also have a surplus for sale. They occupy many different types of country. It is convenient, first, to deal with Queensland and the western part of New South Wales. The 'Acacia semi-desert scrub' and 'shrub-steppe' vegetational types, with Mulga, Myall and Gidgee, occupy the drier parts towards the centre of the continent, and are, in places, well suited to sheep. Downs country, with few trees and an extensive herbaceous vegetation, often dominated by Mitchell and Flinders grasses, is widespread in the regions where the annual rainfall averages between fifteen and thirty inches and the soils are heavy; this, also, is sound sheep country. In the latter rainfall zone, on different soils, areas of scrub and savannah woodland occur. Where most of the rain falls in summer the scrub types are dominated by Brigalow (*Acacia harpophylla*), and where it falls in winter, by Mallee (*Eucalyptus dumosa* and others). The cover on this type of country is generally too dense for sheep except where the vegetation has been removed or extensively modified.

Savannah woodland is found over wide stretches on a variety of soils. Its character varies greatly, the dominant trees varying from place to place according to soil and climate. The amount of herbaceous grazing is equally variable, and depends partly on the extent to which it has been practicable to remove or modify the tree cover, and partly on the fertility of the particular soil type. Among the trees and shrubs, grasses and herbaceous plants are abundant in good seasons. Large tracts of the better savannah country in New South Wales and Victoria have been cleared for wheat-growing, and are, therefore, no longer held by sheep stations of type A1; but few of these are in the particular area now being considered.

The effect of soils on the natural vegetation is well seen in the Mitchell grass country, which is characteristic of large areas of the black soil plains. Here trees and shrubs are few, the original plant life having been herbaceous rather than woody. There are several species of Mitchell grass, differing in palatability (Plate 28), but all are perennial, and have a more or less tussocky growth form. Annual plants ('herbage') are abundant in this vegetational complex after rains. The stock eat the herbage as long as it lasts, and then turn their attention to the Mitchell grasses. If a drought ensues, their tussocks may be eaten down to the roots, but many of the plants survive this drastic treatment. The 'herbage' will grow at all times of the year after heavy rain, but the Mitchell tussocks develop only during the warm seasons.

For grazing purposes the Mitchell grasses, being perennials, are the

equivalent of the shrubs in the semi-desert regions. Grazing management involves the control of the animals in such a way that they will make the maximum use of the herbage while it is present, and will not over-graze the perennial plants when they are the only remaining pasture. On the better soils, where regeneration is easy, little harm is done unless management is bad. On the poorer types it is surmised that some deterioration is taking place, but the amount is not known. The carrying capacity of these areas varies considerably. The sheep population in the areas of Queensland concerned, C, F, G, I and K in Fig. 28, varies between 26 and 110 per square mile. These figures are, however, too low, because considerable numbers of cattle are kept in the same districts in localities specially suited to them; consequently, the averages shown do not represent the full carrying capacity. One sheep to three acres is probably a fair approximation to the safe grazing limits of these districts. In New South Wales, the country west of the Darling is partly marginal, and partly a sound region of the A1 type. In the latter sections the natural vegetation is mostly semi-desert scrub. The sheep population (cattle are not abundant here) has a density of about fifty per square mile, and this represents the highest carrying capacity which experienced men regard as prudent under existing management. Between the Darling and the Lachlan large areas of Mallee and savannah woodland occur, the rainfall being both more reliable and better distributed through the year than in the Queensand A1 areas. Further to the east in New South Wales the character of the country changes, and this will be considered later.

The Queensland areas and this section of New South Wales are almost entirely managed on the extensive plan. Cultivation is rare; the storing of hay or other reserves of fodder is infrequent. In a few special localities where irrigation is possible some lucerne is grown, but the amount is insignificant compared with the stock carried. The general plan of grazing is to limit the sheep to a number that the native vegetation will be able to support, and the amount of feed available in a dry period determines the limit. Nearly every year there are months in which the animals are forced on to the fodder reserves built up by the perennials. During a real drought these reserves become exhausted, and then Mulga and other edible shrubs are lopped, or occasionally the whole plants are uprooted. The Mitchell grass is eaten down, saltbushes are reduced in size, and gradually the owner is forced to make a choice of several expedients. He may buy in feed, send some or all of the sheep away, kill off the less valuable types of the flock, and endeavour to hold the rest, or let them die gradually as the drought deepens.

Several criticisms of this 'extensive' system are made by observers familiar with intensive methods practised in countries with reliable rainfall. They express surprise that little or no attempt is made to conserve fodder during the periods of maximum growth for the periods of scarcity, and hold that this neglect is wasteful of available feed. Again, no attempt is made to grow

reserves by cultivating the land. Further, the diet of the animals is on a rough and ready basis, with no consideration of balanced nutrition.

These criticisms call for some reply. Undoubtedly a certain amount of fodder is not used under the system, but the waste is not as great as outside observers might think. A fair proportion of the material which grows after rain, and subsequently dries off, may be lost, but much remains available although low in nutritive value. It suffers but little deterioration on the ground unless later rains, although insufficient to start fresh growth, are heavy enough to leach out its food value. In fact, the dry climate really turns the dead material into a roughage sufficiently nutritious to maintain the sheep for a time, particularly when the seeds of the herbage are available. However, some waste is inevitable in every system of farming where land values are extremely low and the cash return per head of stock kept is small. Such conditions militate against high efficiency in management.

The question of the storage of reserves of food material is linked with that of labour costs. The stations are run on a labour basis of one man to about three thousand sheep. These men are employed in mustering and moving the sheep (Plate 1), in controlling such troubles as blowfly, in repairing fences, and in attending to water supply and in the other routine of station management. Even if the whole of this labour could be employed in collecting reserves, and an equal number of extra hands brought in during the hay seasons, so that there was available for, say, one month in the year one man per 1,500 sheep, the amount of forage which that man with necessary equipment could gather would be small compared with what the same number of sheep would require, say, during a five-months drought. If the average amount of grass hay collected per man was sixty tons, this amount, fed to 1,500 sheep at the rate of 2 lb. a day, would only maintain them for six weeks. This hypothetical examination of the problem is merely illustrative; economically the practice would be unprofitable if the station could not increase its carrying capacity. This six weeks' reserve would do little more than make up for the need for feeding the animals earlier which would naturally result from the increased rate of stocking. On some properties a certain amount of hay is collected for special classes of stock; but, although the storage of reserves would probably ease the situation during dry spells, it certainly would do little to mitigate the effects of a protracted drought. On prima facie grounds, therefore, there is no general case for making reserves on the grand scale in this type of country. Even if there were, the extra labour force required could not be obtained economically, as there is no local supply of casual workers.

At present hand-feeding usually takes the form of feeding purchased grain or concentrated foods.[4] These are much more easily distributed to large

4. Australian Estates Pastoral Research Service, Pamphlet No. 6, 1938. This company has done a considerable amount of research upon this matter; and

Franklin, M. C., 'Experimental Observations on the Efficiency and Economics of Rations for Drought Feeding of Sheep,' *Aust. Vet. Jour.*, Vol. xxii, 1946.

numbers of sheep than hay reserves, although lucerne hay is used for station horses. Maize has been found very successful in some places; cotton-seed nuts and other readily transportable reserves are used in others. The cost varies, but may be taken at approximately 6d. to 8d. per sheep per week. As the gross return per sheep is of the order of 12s. to £1 per annum in this country, it would not often pay to hand-feed for long periods. The cost of concentrates is largely influenced by the distance over which they have to be carried, and it may seem strange that little has been done in the direction of growing crops on the station. It is true that there is a definite resistance amongst many of the workers on these properties against anything in the nature of 'farm' as opposed to 'station' work. However, further consideration suggests that, owing to the spasmodic nature of the rainfall, crop failures would be as frequent as successes. Attempts to grow wheat on the country between the belt under discussion and the better rainfall regions to the east have been by no means uniformly successful. It is possible that other crops would give better results, but there is no evidencec to show that cropping is ever likely to be practicable on a large scale in the districts under consideration. It may be that, on special soil types in certain districts, crops will be grown, but, it does not seem likely, on the large scale in the near future. In some small areas irrigation may be expected to be developed.

In general, the system of management in vogue is efficient. It may be urged that more should have been done in the way of introducing forage plants to build up the pasturage, but it is extremely difficult to see whether any better grazing plants are likely to be found for these districts than the Mitchell and other grasses. Numerous attempts have been made, but no great success has been achieved, although Buffel and Birdwood grasses (*Cenchrus* spp.) have made good progress in the dry pastoral area in the north-west of Western Australia. It must be remembered that the introduction of a new species of plant into pasturage which is already fairly well established is not an easy task; it is not practicable to undertake a great deal of improvement to land on which only one sheep can be carried to three acres. After all, the actual rental value plus depreciation for properties of this class is usually about two or three shillings a sheep, and not much can be done in the way of cultivation and improvement on land which has such low productive value.

Many efforts have been made in the past to break up the large estates into which much of this country is divided. The political movement to 'bust the big estates' is of long standing, and various devices have been tried by governments, both federal and state, to carry out this policy. Heavy taxes are levied on these properties, particularly where the areas concerned are large; and, as a result of this and other forms of pressure, many of the estates have been broken up, or at least reduced in size, but success has only been partial and it is by no means clear that the policy is a wise one. In Queensland nearly

all the properties are held under a system of leasehold, in accordance with which each lease is reviewed, usually at twenty-year periods. On the better class of properties, when this review occurs, about half the station is normally resumed by the Crown and subdivided into smaller blocks, which are made available for new holders. Under this scheme a certain number of men have been settled successfully; but it seems doubtful whether the small holder, with relatively restricted capital, is able to farm much of this country efficiently. It is largely a matter of luck; if the seasons are good shortly after he enters he may build up sufficient reserves to weather the next drought period. If he is unfortunate, and strikes bad times at the outset, he will almost certainly have to relinquish the property or borrow so much money that he is financially crippled for the rest of his tenure. Some years ago the size of the properties which were set up under these subdivisional schemes were usually worked out on a basis of a sufficient area to carry three thousand sheep. Experience has shown that this number is not large enough, and, nowadays, most of the blocks are designed so as to be able to carry five thousand sheep.

In this somewhat difficult country it may be doubted whether subdivision is fundamentally sound. The living conditions are extremely hard for the individual farmer and his family; his working costs per sheep are seldom as low as those of the large station; and the temptation to overgraze the property and reduce its ultimate value is much stronger in the case of the smaller farmer. He faces periodically the gruesome experience of watching the continuous deterioration of his reserves in the bank, and the steady loss of his sheep through forces against which he is powerless to contend. In this climatic belt it would probably be much wiser in the long run to allow large stations to continue, but to insist upon methods of management which maintained the vegetational balance of the country.

Without taking into account interest on money invested in the stock, the average over-all cost per sheep on a series of large station properties in New South Wales and Queensland of various types suggests that the principal items of annual expenditure before 1939 were of the order given below:

	Per Sheep per Annum
Wages and salaries	1s. 3d.
Shearing, transport and other wool expenses	2s. 2d.
Rent	6d.
Rates and various other levies connected with the properties	3d.
Repairs and maintenance	5d.
Stores and rations	4d.
Replacement of rams	6d.
Sundries	3d.
Depreciation on leasehold	1s. 7d.
Average cost per sheep	7s. 3d.

To these figures must be added an allowance for drought expenses, which may be variously computed. Included in this allowance there is not only the cost of food purchased for the sheep kept during the drought, but also the high price which has to be paid for such stock as are bought when the drought lifts and when there is a demand by all the properties of a district for a fresh supply of animals. The sum concerned will vary widely, but it may be expected to be of the order of 2s. per head per annum, remembering that it will be higher in those districts which have a greater drought risk.

Other studies of costs have been made by various authorities; one of the more recent surveys is that contained in the Report of the Wool Advisory Commission, appointed to inquire into the economic condition of the wool industry in Queensland.[5] In 1939 this body found the average over-all costs attributable to wool and including interest and depreciation and drought costs at 11·1d. per lb., while in the period 1932-38 the costs on an individual holding in the north-west of that state had varied from 13·8d. to 25·0d. per lb. of wool.

The Intermediate Section of New South Wales and North-Eastern Victoria (Figs. 29, 30, 40)

The next subdivision of country which requires consideration is the tract between the Western Division of New South Wales and the ranges. This area comprises divisions B, C, D, F and most of E. With this may be conveniently treated the North-Eastern District of Victoria. This large stretch of land is chiefly plain country, although there are many low ranges with inferior soil types. Its original vegetation was varied; savannah forest was the most frequent type, but there were definite tracts of open savannah and some patches of Mallee and scrub. In many parts of this region the extension of wheat-growing led to an acceleration of clearing, but much of the scrub and Mallee in New South Wales still remains. The region also contains large irrigation tracts which derive their watei from the Murray, the Murrumbidgee, and the Lachlan. Wheat farms are the characteristic features of utilization over wide areas, but a large number of sheep stations of the type A1, and a good many stud flocks, are scattered through these districts. Those of the Riverina are the most notable.

This district differs from those which have already been considered in that the rainfall is generally higher and more effective, usually averaging between 15 and 20 inches, while its reliability is also somewhat greater. The charts for Dubbo, Hay, and Albury (Fig. 41) are indicative of the rainfall in three localities. Hay, on the western margin of the region, with a rainfall of 13·88 inches, has very unfavourable experiences from time to time. Dubbo (21·87 inches) also has had periods during which drought conditions have

5. Govt. Printer, Brisbane, 1939.

prevailed, e.g., 1928 and 1929 and 1937. Albury, on the other hand (27·71 inches) has had dry periods but is seldom seriously affected by drought.

The higher precipitation and the greater degree of reliability make more ambitious methods of land utilization feasible. The average rate of stocking for most of these districts is about three hundred sheep to the square mile, while the cattle population is not inconsiderable. During recent decades there has been a steady increase in the number of sheep in many parts of this zone. This has been brought about by two factors, the expansion of the wheat acreage, which has led to some improvement in the pasturage, and, secondly, the gradual appreciation of the benefit from introducing better grazing plants. In addition, localized areas of river flats and certain sections of the irrigation areas have been brought into the condition of improved pasturage from natural grasslands. In the northern parts of the belt, where the rainfall mostly falls in the summer, the chief plant responsible has been lucerne, the seeding of which has been steadily advocated by the State Department of Agriculture. The soils in the southern section are in many cases deficient in phosphate, but this is not always true in the north. The use of superphosphate in connection with the cultivation of wheat has contributed to the enrichment of the grazing plants. In the moister parts of the southern section, where rainfall is higher in the winter than in the summer, the introduced plants have been subterranean clover (Plate 10) and certain grasses, notably Wimmera rye grass.

Pasture improvement is, however, by no means universal—in fact, it is the exception rather than the rule in these areas. The reason for this is to be found in the rough nature of some of the country, and sometimes in the management of the holdings. Moreover, all soils in this belt do not respond equally well to pasture improvement. There are areas with heavy clays, in which lucerne will not grow readily. There are poor ridges with very little surface soil, usually characterized by the presence of Ironbark trees (*Eucalyptus sideroxylon*), and in various localities, notably in the Riverina, there are great areas of heavy clays, on which pasturage of improved types is not developed at all easily. The whole subject of pasture improvement is a relatively novel one in Australia; and, so far, the departmental staffs available for carrying out investigations have been inadequate. There is little doubt that, as time goes on, and it is practicable to demonstrate the most reliable way of effecting improvements, the change will gradually take place. Naturally, it will occur first in the eastern and southern parts of this belt, where rainfall is higher and more reliable. It is unreasonable to expect rapid developments around Hay, but they are occurring yearly around Albury. Where pasture improvement has resulted in the transition of the property from A1 type of sheep station into type E, the raising of fat lambs is an integral part of the programme.

Western District of Victoria (C on Fig. 30)

In the days of the early pioneers this district was hailed with delight owing to its large expanse of flat country carrying small amounts of scrub, most of which was relatively easily cleared. It rapidly established a very high reputation as a grazing district, largely owing to its immunity from serious drought. The rainfall of most of the area is between twenty and thirty inches; and, although the relatively cold winters retard the rate of pasture growth, and the autumn rainfall is scanty for one year in four or five, conditions are seldom severe enough to cause any serious losses of stock.

Actually the area consists principally of more or less flat plains developed on a series of basaltic lava flows which are geologically young. To the south of these plains lie the Otway Ranges, with higher rainfall and steep slopes carrying dense forest only partly cleared. To the north lie the highlands of the Divide and the Grampians; the soils in the Grampians area are particularly infertile, but those of the Divide contain many rich areas in the vicinity of extinct volcanic cones. Towards its western end the basalt plain gives way to the much lighter type of country characteristic of the South Australian border. Here the soils are lower in fertility, and clearing is more difficult.

The basalt plain itself presents many problems in drainage; creeks are few, and water tends to move slowly away into lakes, most of which are salty. This area originally consisted mainly of grassland, with some patches carrying scattered low trees which presented little obstacle to grazing and tended to die out under grazing conditions. The provision of shelter for stock is a definite problem which is not always easily solved, because few species of trees will stand the effects of a dry summer and water-logged subsoil in the winter, and their establishment is usually difficult.

The area has an average stocking rate of 419 sheep to the square mile. This, however, does not give a correct indication of the carrying capacity of the district, for large tracts of the better pasturage have been diverted to the use of the dairying industry, while most of the sheep stations run some cattle. Some properties are entirely devoted to the production and fattening of beef animals. The total cattle population of the district in 1947 was 509,000, which represents thirty-seven to the square mile.

The properties devoted to sheep-raising vary in size. Today very few really large ones remain, and statistical returns show that in 1946 there were twelve with over 15,000 sheep and twenty-six with between 10,000 and 15,000. In the early days most of the stations carried Merino sheep, and were concerned almost solely with wool production. Gradually, with pasture improvement and the spread of disease, the wetter parts of the area were found to require breeds which were less liable to foot-rot and other troubles; Polwarths, Corriedales and crossbred types have, therefore, partly replaced Merinos over such areas in recent years. Pasture improvement has made

great strides in the last two decades and the whole character of the grazing material has shown corresponding changes. One effect has been to diminish the areas concerned solely with fine wool production, so that an increasing number of properties expect to derive considerable revenue from the sale of stock. Another effect of pasture improvement techniques has been to increase the pressure for subdivision of the larger properties since smaller areas have become economic.

The management of the sheep on the properties is usually efficient. This does not imply that all sheep are kept in first-class nutritional condition throughout the year; but, on the great majority of the stations, sufficient hand-feeding is done, particularly of ewes and stud sheep, to maintain them in reasonable condition during the winter period of scarcity on the pastures. In some seasons the amount of hand-feeding done is small, in others large quantities of oats and sometimes hay are used for this purpose. The practice of making meadow hay is spreading in some areas, particularly on the smaller properties. The improvement of the pasturage resulting from the practice of top-dressing with superphosphate has stimulated hay-making, which was previously impracticable, because the growth of the native pasture is seldom sufficient to warrant the collecting of forage reserves.

From the standpoint of land utilization the chief question to be decided in this district is whether the land could be more effectively used under a system of mixed farming. The answer to the question is largely dependent upon the nature of the soil. In some places farmers have discovered that the spread of clovers consequent upon the use of superphosphate has so improved the condition of the soil, both in fertility and structure, as to make cropping with wheat a profitable practice, thus affording an instance of transition to 'ley' farming.[6]

Occasional wide stretches of country occur in which basaltic boulders are freely interspersed through the soil, rendering cultivation difficult or impossible, and in places the surface of the lava flows have collapsed to form patches of broken stony country known as 'stony rises'. In such regions cultivation is, of course, entirely impracticable. In some sections of the district, where recent volcanic cones have given a thick covering of fertile ash to the surrounding area, the land is put into cultivation as a normal procedure, and is used for the production of potatoes or onions. The soil of other large sections consists of heavy clays, which are only cultivated with difficulty[7] and parts of which are subject to inundation for varying periods in

6. Under a 'ley' system of farming the land is put down under pasture plants for a series of years; crops are then grown on it for one or more years, after which it is again put down to pasture. Leguminous plants are usually held to be an essential component of the pasture. The benefits of the system are that it induces a better soil structure which gives easier cultivation and higher yields of grain per acre.

7. For the study of a typical area, see Leeper, Nicholls and Wadham, *Proc. Roy. Soc. Vic.*, Vol. 49, part 1, 1936.

the winter time with consequent difficulty in establishing crops or profitable pastures. Apart from these special cases there are, however, numerous areas which could still be brought under the plough and used for mixed farming. The principal obstacles to this procedure are partly the traditional use of the land as sheepwalk, and partly the lack of men with the detailed knowledge required to carry on mixed farming operations with success. This type of country could grow some wheat, but its quality would not be high, and, apart from fat lambs, the main saleable products would be precisely those which are already produced by the stations in a reasonably efficient way. Large

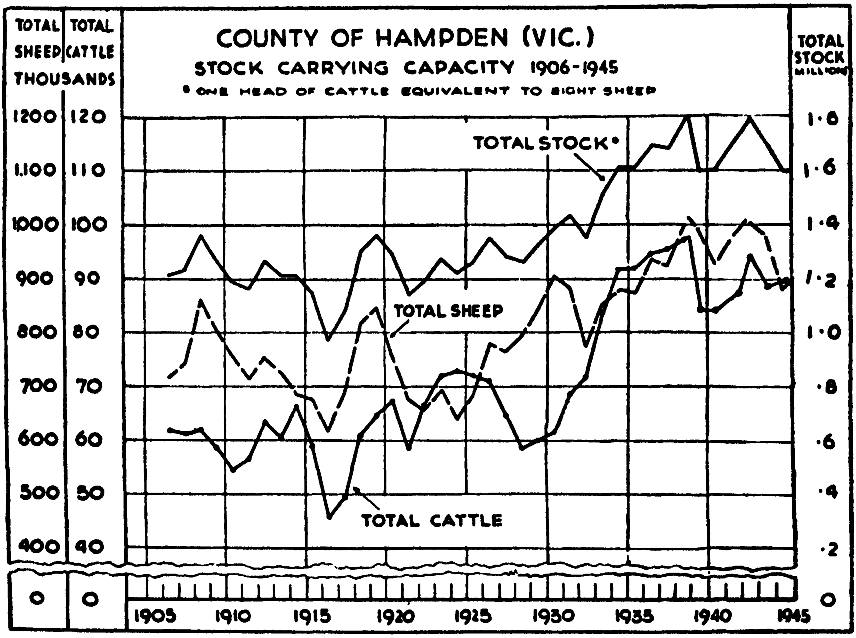


Fig. 42. Change in the Stock-carrying Capacity of County Hampden, Western District, Victoria

areas have been subdivided into farms of about 500-1,000 acres and many of these farms are now in a prosperous condition though not necessarily under the original ownership. Many of the original settlers were unsuccessful because of inadequate areas, inexperience, lack of capital, unsuitability for the life, or all four causes. Pasture improvement now enables smaller areas to prosper, due to more diverse production, cheaper cultivation and ability to restore depleted soil fertility. However, the increased stocking rate also results in greater liability to foot-rot, worms and other diseases which necessitate more knowledge and a more careful husbandry.

South-Eastern Division of South Australia (G on Fig. 31)

The basalt plain of the Western District of Victoria ceases thirty miles from the South Australian border, and from this point a savannah vegetation dominated by Red Gum extends into South Australia, and occupies considerable areas in the south-east of that state. The soils which bear it are sandy in nature, with heavy subsoil clays. Some description of the vegetation and methods of clearing have already been given in chapter III.

In some localities, particularly to the north, the soils are deep sands, poor in quality, bearing heath or Mallee vegetation. These are readily cleared, but the inherent lack of fertility is an obstacle to rapid development.

In addition to these two types, there are wide expanses of clay flats separated by parallel ridges of calcareous sandstones which represent ancient coastal sand-dunes. During the winter these flats are liable to flooding and the ridges prevent easy natural drainage. As the country has a dry summer climate, it is virtually impossible to effect any improvement in the pasture without the development of extensive drainage schemes. One such scheme has already been installed in the Millicent area. Other larger schemes have been debated and reported on by various investigating bodies from time to time. The principal difficulty in the past has been the large capital cost of the schemes, which would require a considerable annual rate. Landowners have not felt convinced that the benefits from the scheme would enable them to meet this charge. The Report of the Parliamentary Standing Committee on Public Works on South-Eastern Development (South Australia) in 1936 suggested[8] that other areas without drainage problems could, with scientific management, be brought under an intensive scheme of production more cheaply. However, the pressure for land for soldier settlement in the post-war years is sufficiently great to make it probable that the drainage scheme will be adopted, the government resuming a large part of the land from its present owners and subdividing it for settlement subsequent to drainage.

In addition to these districts of Red Gum country, clay swamps and sandy heaths, there is an area of coastal sand which forms a narrow strip along much of the seaboard. This is particularly interesting owing to the difficulties which have been experienced in breeding and carrying sheep. These have now been investigated scientifically, and seem to be caused by a deficiency of copper in the pastures.

The area is thus a complex one. The average rate of stocking at present is 193 sheep to the square mile. There seems every reason to suppose that this will be increased as the development and utilization of the area proceed along scientific lines. In the past the sheep on this land have been mostly used for fine wool production; but the intensification of the pasture management is rapidly bringing it into a position in which the farmers can produce for the fat lamb market. It seems quite clear that the area cannot be

8. Govt. Printer, Adelaide.

effectively transferred from a wool basis to a wool-plus-meat basis unless there is a prospect of greater security in the future for the Australian meat export industry.

Other Districts of South Australia (Fig. 31)

In the 'Murray Mallee' Division, the area south of the river is about 6·4 million acres. This is largely occupied by wheat and sheep farms, but it also contains numerous tracts of poor country used for sheep grazing only. North of the river there is an area of about 2·7 million acres, with an average rainfall of less than ten inches. This, apart from small irrigation areas and a few wheat farms, is entirely grazing land. The adjacent Central and Lower North Divisions contain the southern extension of the Flinders Range, Kangaroo Island, and the rich agricultural areas of the Adelaide plains and Yorke Peninsula. The rainfall is fairly good, and reasonably reliable over much of this country. The stocking rates of 196 and 182 per square mile would be much higher but for the large expanses of country which are either stony and rough, as in the ranges, or poor, as on Kangaroo Island, where 1,075,200 acres at present only carry 97,000 sheep. The development of a technique for using this country has already been discussed (p. 99). The pressure of land settlement in South Australia has been such that agriculture has been developed wherever there was a reasonable chance of success; properties devoted solely to sheep are either on the less fertile soils or on the inland side of these divisions. In the Upper North Division, cropping becomes much more speculative owing to the lower rainfall (less than ten inches) and the unreliability of its occurrence. Consequently, light grazing is the most that can be expected. In part of the area the vegetation is saltbush, and the tendency to wind erosion has been referred to. Detailed studies on some of the ecological problems of these marginal districts have been carried out on the Koonamore vegetation reserve.

The Western Division is variable; its northern margin is light grazing country; a strip running across Eyre Peninsula is occupied chiefly by wheat farms, with some sheep, while the rainfall at the southern extremity of the peninsula is high enough to support improved pastures, to the displacement of the cereal crops. The 'Area outside the Counties' is marginal or desert country, on which the average rainfall is almost everywhere less than ten inches and unreliable in its incidence (Figs. 17 and 19). Attention has already been drawn to the data for Tarcoola in the discussion on Fig. 41.

Western Australia[9] (Figs. 32a, b, c)

In the Eastern Goldfields Division the natural vegetation was chiefly Mallee and sclerophyll woodland with a considerabe section of Nullarbor

9. The authors are indebted to Mr. A. L. B. Lefroy for criticism of the material of this section, and to Professor J. E. Nichols for assistance in its construction.

shrub steppe at the eastern end. The low rate of stocking of this country (one sheep per square mile), though occasionally the result of the comparatively dense nature of the natural shrub and tree cover, is principally due to difficulties in obtaining supplies of potable water, and to the presence of dingoes and wild dogs in considerable numbers. Rabbits have also spread into this area despite the barrier which the Nullarbor Plain presented to their progress. A peculiar difficulty of many parts of the region is the high degree of salinity attained in many of the soils. This is said to be due to the deposition, extending over thousands of years, of the salt borne in by winds from the south-west. There are no rivers, and all drainage is internal; salt lakes are numerous. The soils are poor and sandy, and an attempt to develop the Norseman-Esperance region on a wheat basis has been largely abandoned after the loss of large amounts of capital.

The Northern Goldfields Division had, for the most part, a natural desert vegetation of spinifex grass, but there are numerous regions in which Mulga and other shrubs are the dominant feature. Saltbush and bluebush are also prevalent in places. The rainfall is extremely low and unreliable (Figs. 17 and 19). In places the desert takes on a stony nature, while a siliceous hardpan in the subsoil is a marked feature of some districts. This has at least one advantage, because where it occurs rabbits are never a menace. This formation is a curious one and is said to be the subsoil of an old ferruginous topsoil.

The South Murchison country (the south-western part of the Northern Goldfields Division) is, for the most part, covered with Acacia semi-desert scrub, with many varieties of Mulga as the chief tree form. Most of this area has been occupied by pastoral stations for a long period. The average rate of stocking on these stations was about sixteen sheep to the square mile in 1945.

The Northern Division contains a northern extension of the area just described, which almost reaches the sea south of Broome. To this the Kimberley district, farther north, stands in strong contrast; here the rainfall is of the summer monsoonal type, and part of the country consists of open grass plains alternating with savannah woodlands. Unfortunately, a considerable proportion of the high rainfall region is very rough topographically and as a result has defied successful occupation. This area is traditionally utilized for raising cattle, which are either shipped from Derby to Perth or slaughtered at the meatworks at Wyndham for export trade. There are several large sheep stations in the West Kimberleys, and during recent years there has been some tendency for sheep to replace cattle in this region. This movement will continue if the beef industry does not receive prices which make it possible to improve its methods; on the other hand, it is equally dependent on the world position of wool. This extension of wool-growing in the Kimberleys may also be expected to receive some stimulus if the recommendations of the Board of Enquiry on the Land and Land Industries of the Northern

Territory to stimulate the development of the adjacent Victoria River District as sheep country are implemented.

Investigations[10] on the grazing value of the Mulga and other Acacias have demonstrated a considerable variation between the species and forms within the species, and have also emphasized the worth of this plant from the point of view of feeding the sheep. It is stated that 75 per cent of the Mulgas are edible, and that regeneration is taking place freely. As is usual in such vegetational areas, the Mulga is associated after heavy rain with a wide array of herbage plants. During drought periods the Mulga is lopped or felled, and the sheep are able to maintain reasonable condition. It has been estimated that a daily intake of 3 lb. of Mulga leaves and twigs will maintain sheep in good condition; but the labour of providing this amount of material on a sheep station is considerable. It will be clear that the danger of over-lopping the trees during a drought sets the limit to the carrying capacity.

The presence of large mining areas in some of these districts has put an extra strain upon the amount of timber which is left undestroyed, but timber cutting for mining purposes is now restricted by the Forests Department. It has been claimed that the deforestation is likely to result in deterioration of the soil through wind erosion; and although there is sufficient ground cover, in the form of twigs and edible shrubs, to prevent serious effects and to maintain regeneration in many places, yet in others erosion is becoming serious.

The North-Western Division contains some belts of country similar to that which characterizes the South Murchison. In general, however, the dominance of Mulga is less pronounced. In the Roebourne, Marble Bar and De Grey area, to the north-east, the precipitation has a definite summer incidence, and spinifex finds an increasingly important place in the herbage, which assumes in places the characteristics of desert vegetation. There are also tracts of hilly downs and certain flood plains on the east which are extremely fertile, and have a high carrying capacity after rains.

The rough hill country lying behind Onslow, in the Ashburton region, bears areas of fairly good perennial hill pasture, which are most valuable when used in conjunction with the mixed grasses of the lower plains country which flourish after rain. The stocking rate in this region was eight sheep to the square mile in 1945, a considerable reduction on earlier figures owing to the recent droughts.

The exceptionally long drought period of 1935-39 caused very severe losses in most of these pastoral districts (Figs. 32b and 32c). The Report of the Royal Commission appointed to enquire and report on the financial and economic position of the pastoral industry in the leasehold areas of

10. Nichols, J. E., 'Investigations in the Pastoral Areas in Western Australia,' *Jour. Aust. Inst. Agr. Sci.*, Vol. 4, No. 1, 1938; and Melville, G. F., 'An Investigation of the Drought Pastures of the Murchison District of Western Australia,' *Jour. Dept. Agr.*, Vol. 24, 1947.

Western Australia[11] showed that in all regions except the West Kimberley the number of stock units had been halved between 1934 and 1939; large financial losses had been incurred and there was an increase in soil erosion in some districts. The same report gives interesting data concerning costs of producing wool in these districts. In general, these are of the same order as those in New South Wales and Queensland referred to on p. 108.

The main sheep population of this state is carried in the better rainfall areas of the south-west. The country concerned is partly used for wheat production, but in the poorer and wetter sections sheep are frequent. Some are carried on the native vegetation, but in many regions the soils are poor and only the use of abundant phosphate enables a good pasturage to develop. In some places traces of copper are also needed. Recently some of these pastures have come under suspicion as being the causes of serious dystocia[12] in the sheep; this problem is under investigation. Until it is solved, breeding will be difficult.

Tasmania (Fig. 33)

In Tasmania the sheep are mainly kept in the drier Midlands or on certain large estates in the Eastern and North-Eastern Divisions, the remainder of the state being too rough or too wet. The Tasmanian stations have a special historical interest, because the wool industry was established firmly in Tasmania at the beginning of the nineteenth century and the flocks of the island early developed a great name for fine wools. For some decades they were the chief source of supply of rams for some mainland areas, such as the Western District of Victoria and the Southern Riverina. Later these districts themselves developed their pedigree flocks and the Tasmanian trade in stud animals diminished, although relics of it still remain today. As Davidson[13] has shown, the sheep population of the island remained relatively stationary for sixty-five years from 1859 to 1924. Since then pasture improvement has increased carrying capacity and has also led to a change in the proportion of animals kept for fat lamb trade.

3. SHEEP ON WHEAT FARMS

The position of sheep on the wheat farms deserves some special consideration. Broadly speaking, the same principles apply throughout the wheat belt of Australia. In each state, during the phase of rapid expansion of wheat-growing when areas were subdivided into farms with the definite object of growing wheat, the farmers focused their attention on the production of the grain because it was generally profitable, and also because the land was often only partially cleared. Frequently fences were not sheep-proof,

11. Govt. Printer, Perth, 1940.
12. Bennetts, Underwood, Shier, 'A specific breeding problem of sheep on subterranean clover pastures in Western Australia, *Aust. Vet. Jour.*, Vol. XII, 1946.
13. Davidson, J., 'On the Growth of the Sheep Population in Tasmania,' *Trans. Roy. Soc. S.A.*, Vol. 62, 1938.

water supplies were somewhat precarious, and in many cases the areas allotted to the settlers were too small for a man to carry a commercial flock. Consequently, such small flocks as existed were kept more for home use than with an idea of increasing the cash income. Gradually, as blocks were amalgamated or allotted on a more generous scale, and the need for fallowing as an essential practice in many districts became recognized, there was more opportunity for men to keep stock of one kind or another. Today it is generally agreed that wheat-growing without sheep is inadvisable.

The following table shows the extent to which this generalization has been put into practice in the four main wheat-growing states.

Relation of Sheep to Wheat-growing in Four States, 1935-36

	Number of Wheat Farms with Sheep	Percentage of all Wheat Farms	Number of Sheep on these Farms in millions	Sheep on Wheat Farms as Percentage of Sheep in the state
N.S.W. . . .	13,627	85·58	13·39	25·78
Vic. . . .	9,974	72·38	4·84	27·73
S.A.	8,672	67·82	3·75	47·21
W.A.	6,744	74·61	4·48	40·45
Aust.	39,017	75·72	26·47	29·93

Computed from *State Year Books* and *Statistical Registers.*

Inferences from these figures must be drawn with some caution, as they undoubtedly include data from some properties on which wheat production is very much of a side-line when compared with running sheep. The interesting fact is that about a quarter of the Commonwealth's sheep are carried in the wheat zone.

The actual feed available for flocks on wheat farms is derived from various sources. There is a valuable picking on the stubbles for a period after harvest, and, if rain happens to fall in quantity during December or January, this may become a luxuriant growth. There is the weed growth on the fallows, which, although sparse, is useful; on some farms the sheep are largely kept for the purpose of reducing the amount of cultivation required. Occasionally wheat crops which have developed too far in early winter require to be checked by grazing. Apart from these sources there also is the grazing on those sections of the farm not under cultivation. This last category includes odd areas unsuitable for cropping, because of soil or topography; but, more important, it covers those areas which have been allowed to 'run down' to volunteer pasture for a few years. On lighter soils many farmers have realized that spelling the land from cropping for a period, and using it as a sheep-run, leads to better yields of wheat than where

'wheat-fallow' alone is practised. This independent discovery of the need for a rotation in land usage is interesting. The obvious extension of such a system is to introduce a crop of some grazing plant which would give better growth than the volunteer pasturage; the disadvantage of the latter method is that it allows the multiplication of undesirable weed plants among the herbage. It seems probable that a major development in this direction may be expected in the future, but the problem is not as easy of solution as might be thought. The volunteer herbage is sometimes valuable. It differs according to the district; in some places Wimmera rye grass, medicks or clovers are prominent, in others barley grass is the best species which appears. Where it is valuable there is no advantage in incurring the extra expense of introducing some other grazing plant. Where the natural plants are less satisfactory, the difficulty is to find some other species which can be grown with success and profit. Most of these districts have light rainfall, and so far some type of oat suitable for grazing is the most successful plant for the purpose. Some farmers have, therefore, adopted the policy of drilling in oats on the stubbles. Where winter rainfall is more reliable, peas are sometimes sown, and in some limited areas of the Western Australian wheat belt lupins are used, although here it is the seed of the crop which is eaten by the stock in the ensuing summer. Cruciferous crops are too speculative to be satisfactory in most districts, but are occasionally grown with success.[14]

Generally the shortage of feed for sheep arises at different seasons in different districts. In the southern wheat areas it is from March to July in seasons when rain comes late; in northern districts it is during the winter or early spring in those seasons when winter storms are absent. In the former case, no extra cropping will make up the deficiency, because there is no growth of any kind; in the latter, the farmer can meet the deficiency by sacrificing part of his wheat crop, which has probably made some progress on the water stored in the soil from the summer rain. In the average season there is fair feed, but about one year in four or five hand-feeding becomes necessary if the condition of sheep is to be maintained.

Usually the sheep are kept with the objective of fat lamb production; but, in districts where transport facilities do not allow lambs to reach the saleyards in good condition, 'dry'[15] sheep are run. The acreage of the farm in relation to the area under cultivation is an important consideration. A man on a small farm, who has only sufficient area (say, four hundred acres) to employ one set of machinery and one power unit on a wheat-fallow basis, is not in a position to run a flock of any size; he will probably let the grazing

14. Some information due to the results of 'ley farming' with subterranean clover is given by Morrow, J. A., 'Clover-Ley Farming,' *Jour. of Agric., Vic.*, Vol. XXXVIII, 1940, p. 205; Hayman, R. H., 'Maintenance of Soil Fertility and Production,' *Jour. of Agric., Vic.*, Vol. XLI, 1943, p. 329; and Killeen, N. C., and Bath, J. G., 'Development of Clover-Ley Farming at Rutherglen Research Station,' *Jour. of Agric., Vic.*, Vol. XLVI, 1948.

15. Dry sheep are non-breeding ewes or wethers kept solely for wool production.

on his stubbles and fallows on agistment. At the other extreme, a man with a large property on less valuable land will probably crop about a fifth of his area, and may be able to specialize in fat lamb production or in the maintenance of a flock for high-grade wool.

During the period of economic depression of 1929-35 it became clear that wheat-growing had been developed too far on the inner side of the wheat belt and that some regions which had been cleared for wheat had too low and too uncertain a rainfall for success. Attempts have therefore been made to aggregate wheat farms in these districts with the intention of using the land for grazing sheep. The natural carrying capacity is low in most of these regions and the change has required large reductions in the debts of the remaining farmers. The nature of the reconstruction required in Victoria is set out in the report of the North-West Mallee Facts Finding Committee.[16] Although many men have been remarkably successful in this venture, others, who probably compose the majority, only began to realize the value of sheep on a wheat farm both to the wheat crop and also to the bank account during the depression of 1929-35. Consequently, for many farmers the venture is a new one, and the tricks of the trade have yet to be learnt. A further discussion of the problems confronting this and other types of farming in producing sheep for the meat trade follows in the next section.

In the eyes of a British farmer the method of keeping the sheep and raising the lambs would appear a very casual proceeding, but he would probably fail to realize two important points. First, the remarkable way in which sheep, even lambing ewes, maintain their condition on relatively little feed in a dry season, under the conditions of the Australian wheat belt. Secondly, that, although early lambs brought £1 or over before World War II, the average price of the product of most districts (including those which had to be sold as stores) could not be reckoned at much over 10s. net. It is not possible to be lavish in expenditure at such price levels.

4. NON-BREEDING WOOL DISTRICTS

Reference to Fig. 40 shows that the non-breeding districts are confined to a few special areas. In the northern tablelands of New South Wales the climate is cold in the winter, while rainfall is fairly high in summer. The country has many steep slopes, and pasturage is relatively poor in many places. Breeding is somewhat risky, and young stock find conditions too hard for satisfactory development; consequently, the land is used for grazing sheep which have been 'brought in' from more favourably situated stations. Some of the southern tablelands of New South Wales, e.g., the Monaro, are similarly used.

Other areas, where breeding in the past proved unsatisfactory on many properties, lie in South Australia, on some of the light coastal and 'desert'

16. Govt. Printer, Melbourne, 1946.

country of the South-Eastern Division, on Kangaroo Island, and at the end of Yorke Peninsula. Here, although winter rainfall is high, the main factor seems to be poverty of the pasturage associated with mineral deficiencies. Recent scientific work indicates that these difficulties are not insuperable, and it seems likely that, under appropriate treatment, much of this land can be made into breeding and even fattening country. In Western Australia, similar problems arose in the Gingin country, about fifty miles north of Perth. Here, again, the solution lies in improving the feeding systems, and by improving the pasture by the introduction of subterranean clover and the use of superphosphate together with small quantities of a copper salt.

5. SHEEP-FATTENING AREAS

Sheep stations of class A (see p. 92 and Figs. 39 and 40), situated in areas of better rainfall, usually expect to have considerable numbers of surplus animals for sale during part of the year. Occasionally from some districts these may be turned off as 'fats', but more often they are sold in 'store' condition. The sheep concerned belong to several categories; they may be those whose teeth are beginning to break to such an extent that they are no longer able to maintain reasonable condition under the somewhat rigorous circumstances of station life. They may be young sheep in excess of the normal carrying programme of the station, and in this case they will be the less efficient animals, i.e., culls, from the wool-growing point of view. Under special circumstances, when the season is particularly unfavourable, and the rate of stocking has to be seriously reduced, relatively high-grade animals are sold for what they will fetch, irrespective of their normal value.

The destination of the animals is variable. Ewes capable of producing a lamb or two, if living under easy conditions of feeding, are generally taken by farmers who raise fat lambs; weaners go to districts capable of turning animals off in prime condition at those seasons when the meat market is short of supplies, or they may be kept on some farms as small flocks for wool. Old ewes are transferred to locations climatically too difficult for breeding, but having enough pasturage to fatten them at the appropriate season.

Before the days of pasture improvement these farms were restricted to areas of good soil in districts where rainfall was higher and better distributed than in the wool-growing districts. Where rapid transportation to market was available, the gradual change in the management of wheat farms noted in the preceding section developed a new zone of production specially suited to the fat lamb industry, but on these farms the period during which fat lambs can be marketed is usually confined to the spring. Grazing material is generally too dry and too scarce for fattening at other periods, while spiky grass-seeds tend to collect in the wool on the animals' heads in the late spring and cause wounds unless special precautions are taken. The development of irrigation areas supplied with water at a cheap rate made it possible for some

farmers, who understand pasture management, to fatten animals for markets at times when supplies from the wheat belt are short. Finally, the advances which are being made in pasture improvement on poorer soils in the coastal and hill regions of better rainfall areas have further increased the number of farms which are able to produce fat animals at one season or another.

Although the primary objective of most farmers who operate on the fattening country is to utilize pasturage as much as possible, crops are frequently grown to provide extra feed during the seasons when the grass-lands are not sufficiently productive. The range of crops is considerable, and varies with the district—oats, barley, sudan grass, millet, turnips, rape, all have their place. It would, however, be wrong to infer that the industry has in all cases evolved the most satisfactory system of farm management to suit this type of production. The problems which present themselves from the standpoint of the carcase will be further discussed in chapter IX.

The expansion which has already taken place in the lamb and fat sheep areas is a phase of the intensification of land usage in Australia which is by no means complete. The wider outlook towards pasture management, the development of more efficient systems of cropping, the better appreciation of the principles of nutrition and of the finer points in flock management for this purpose, all of which are gradually developing in most districts, suggest that the future will see considerable changes in methods and further extension of the utilization of land for this purpose. The only question is the extent to which markets can be found for the resultant products.

The alteration in methods of management in changing a wool-sheep property selling some surplus sheep to a sheep-fattening property is considerable. It involves an alteration in the type of sheep kept, and, therefore, in the type of wool produced, usually with a reduction in the value of the wool per sheep, but not per acre; it demands a considerable capital outlay in subdivision of paddocks and in the provision of extra water supplies; it also means a greater labour force and more outlay in connection with the pastures for manures and seed; it also demands larger amounts of reserve fodders against drought periods. These extra charges are usually met by increased returns, but the final result depends on the price levels for fat stock and various types of wool. In short, it is a course which is not to be embarked upon as a pure experiment; it evolves naturally through the improvement of pasture management and the introduction of higher grades of forage plants, such as the more efficient types of clovers. It is now known that this change is far more readily achieved on some soils than on others, even in a single district of uniform climate.

6. SHEEP MALADIES AND DISEASES

Apart from the provision of suitable feed the chief difficulties of the sheep-owner are those caused by disease or other ailments in the flock.

Australia is fortunate in being free from many serious troubles common in flocks in other countries. This is probably due to three causes: first, the fact that no ruminant animal was present in the native fauna; secondly, an effective system of quarantine has prevented the entry of many diseases; and thirdly, most of the sheep areas have a very healthy climate, the dryness of which prevents close stocking and thereby diminishes the risk of infection. However, the number of pests and diseases which affect the sheep is still quite large enough. They can be roughly grouped in three classes—external parasites, internal parasites and diseases.

Among the external parasites the blowfly is the most important. Its ravages have been extremely serious, especially in the regions of summer rain. The whole subject has been investigated from many aspects by research workers. Fly strike may occur on any part of the body when conditions are humid and the wool becomes wet, but the most usual place is in the crutch. Investigations have shown[17] and experience confirms that the removal of surplus skin by a simple surgical operation on the lamb can give a high degree of freedom from crutch strike in the adult sheep. The worst phase of the trouble can therefore be avoided in many districts.

It is interesting to note that in the latter half of the nineteenth century sheep scab was prevalent and caused great trouble, but was stamped out, presumably by the rigid enforcement of regulations designed to prevent its spread. Lice and ticks are controlled by dipping, which is compulsory in all states when a stock inspector demands it and is an annual requirement of the law in a majority of states.

The internal parasites are chiefly worms of various types, climatic conditions determining the chief trouble in each district. Their importance is largely influenced by the level of nutrition of the animals, and consequently this incidence varies greatly from season to season. They are mainly held in check by drenching, supplementary feeding, and by rotating the grazing animals from one pasture to another. Liver fluke is controlled by eradicating its intermediate host—the water-snail—wherever soaks and other wet spots can be treated with copper sulphate.

Numerous infectious diseases occur and at times cause serious economic loss. In many cases efficient control measures have been evolved, e.g., vaccination as a preventive of black disease; the control of foot-rot by eliminating 'carriers' from the flock.

Trace element deficiencies are of extreme importance in some areas, e.g., coast disease, which is controlled by administration of small amounts of copper and cobalt salts.

Many diseases are still of unknown etiology; for instance, toxaemic jaundice which is associated with a high storage of copper in the liver; and

17. 'Recent Advances in the Prevention and Treatment of Blowfly Strike in Sheep,' by the Joint Blowfly Committee, *C.S.I.R. Bulletin*, No. 174.

infertility and other effects on certain pastures in which subterranean clover is dominant.

These problems have been and are the subjects of a great amount of research work by the staffs of the C.S.I.R. Division of Animal Health, the veterinary sections of state departments and universities.[18]

18. No attempt can here be made to review this work completely. The Annual Reports of the Council for Scientific and Industrial Research give a yearly review of the situation, while those of the Glenfield Research Station and various papers in the *Australian Veterinary Journal* will be found to be other fruitful sources of information.

Chapter VI

THE RELATION BETWEEN WOOL MARKETS AND LAND UTILIZATION

1. The Place of Wool in the Australian Economy
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Chapter VI

THE RELATION BETWEEN WOOL MARKETS AND LAND UTILIZATION

1. THE PLACE OF WOOL IN THE AUSTRALIAN ECONOMY

THE successful expansion of wool-growing was the mainspring of Australian development. Without it there would have been little progress before the gold discoveries, and little stability after the gold boom was over. For Australia in the nineteenth century, as for England in the fourteenth, wool became the great national industry—the staple. Even today, when the growth of Australian population has brought many other rural industries into prominence, and when manufacturing has been successfully established and is rapidly expanding, wool still retains its predominance. In value of output it is still the largest single industry, and it contributes the largest individual item in the export trade of the Commonwealth (Plates 29 and 30).

The relative importance of wool in both production and export is indicated by the following table, showing (a) the Australian clip compared with world production, and (b) the value of wool compared with that of other primary industries.

Wool: Australian and World Production; also Gross Value of Other Primary Products

(Averages for two-year periods)

	1929/30-1930/31	1931/32-1932/33	1933/34-1934/35	1935/36-1936/37	1937/38-1938/39
Greasy Wool (Australia) —million lbs.	925·7	1,035·0	1,005·6	976·9	1,003·5
Greasy Wool (World) —million lbs.	3,850·8	3,854·0	3,683·0	3,736·8	3,933·8
Gross Value of Australian production of—					
1. Wool £m. (a) ..	39·5	36·8	51·7	59·6	48·0
2. Wheat „ „ ..	26·1	33·5	26·3	35·1	29·5
3. Dairying „ „ ..	34·7	30·4	27·3	33·0	39·7
4. Minerals „ „ ..	14·4	16·6	21·5	29·8	34·6

(a) Australian currency.

Computed from *Commonwealth Year Books* and *Production Bulletins.*

It is not until the value of wool in total export trade is examined, however, that its full significance in the national economy is realized. The comparative figures are given below.

Importance of Wool in Australia's Export Trade
(Averages for three-year periods)

	1932/33-1934/35	1935/36-1937/38	1938/39-1940/41
Value of Australian Wool Exports £m.(a)	44·3	53·9	46·4
Value of Australian Total Exports £m.(a)	116·5	148·5	138·4
Percentage of Value of Total Exports supplied by—			
1. Wool	38·0	36·3	33·5
2. Wheat and Flour	14·4	15·7	10·3
3. Fruit (Dried and Fresh)	3·8	2·9	2·7
4. Butter and Cheese	7·9	6·9	10·7
5. Metals (Lead, Copper, Zinc, Tin, Gold, Silver)	14·4	12·7	*
6. Manufacturing Industries	3·9	5·0	10·3

Computed from *Commonwealth Year Books* and *Production Bulletins*.
(a) Australian currency.
*Not available.

One factor of great importance for consideration at this stage is the distribution among overseas countries of Australia's wool exports. As will be seen in the table below, the order of the main importing countries, measured by quantities received, did not change greatly in the two decades prior to 1940. The United Kingdom, France, and Japan accounted for between 70 and 80 per cent of the Australian export, with a sustained tendency for the export to countries outside these three to decline. This was especially true for Germany, the United States, and Italy. During World War II the

Wool Exports from Australia

Country to which Exported	Five-year Average, 1922-23 to 1926-27	Percentage of Total	Two-year Average, 1937-38 to 1938-39	Percentage of Total
	m. lb.		m. lb.	
United Kingdom	251	37·2	347	42
France	164	24·3	152	19
Japan	63	9·3	72	9
Germany	57	8·5	47	6
Belgium	56	8·3	102	12
U.S.A.	46	6·8	13	1
Italy	30	4·4	26	3
Other countries	8	1·2	66	8
Total	675	100·0	825	100

Computed from *Commonwealth Year Books.*

acquirement of Australian wool was confined to British countries and the United States, with severely restricted supplies to unoccupied countries in Europe and Asia. Resumption of the pre-war pattern of distribution will depend on the rehabilitation of former consuming countries, on the success of international policies for freeing trade channels, on competition of artificial fibres with wool, and upon the general level of world prosperity. Special aspects of this general problem are discussed in later sections of this chapter.

2. WORLD MARKETS AND AUSTRALIAN EXPORTS

Australia produces about one-quarter of the world's fine wool output, far more than any other single country. Nearly 80 per cent of the annual clip of about 1,000 million lb. is 'fine' (or apparel) wool. Every country which specializes in the manufacture of woollen cloth draws heavily upon the Australian clip, and few countries using any type of wool as a raw material can avoid dependence upon Australian supplies.

The broad facts can best be shown by the figures for world trade in wool. The physical volume of purchases from the main suppliers by the principal wool-using countries should be compared with the home production of the main importing countries. The table is given below, and it will not be necessary at this stage to do more than draw attention to its implications for the Australian wool producer, and for the future of Australian sheep-growing areas. A comparison of the figures in columns B and C shows where the main demand for Australian wools existed in 1938, and emphasizes the part played by Australia in the business of supplying wool to countries that have specialized in woollen textiles. Of the 2,153 million lb. entering world trade

Wool: Principal Importing Countries and Sources of Supply, 1938

(Millions of lb.)

Importing Country	Production of Importing Countries (Unscoured) A.	Total Imports B.	Quantity imported from:				
			Australia C.	South Africa	New Zealand	Argentine	Other
United K'gdom	110·0	881	365	107	198	79	132
Belgium	·7	217	106	19	7	20	65
Czechoslovakia	2·0	29	18	4	—	6	1
France ..	54·4	390	168	52	22	62	86
Germany ..	44·5	306	49	90	14	56	97
Italy	33·0	76	19	22	—	12	23
Japan	—	117	87	5	11	6	8
Poland ..	12·9	34	14	2	4	14	—
U.S.A. ..	457·7	103	7	1	4	47	44
Total ..		2,153	833	302	260	302	456

Source: *Commonwealth Year Book*, No. 36.

in that year, 833 million lb., or nearly 40 per cent, were exported from Australia.

The character of the demand for wool as illustrated in the case of Great Britain is of great significance. The main division to be noticed in the manufacture of wool is that between the woollen and worsted sections of the industry. They are, indeed, not so much sections of an industry as different industries using different types of wool, employing different processes and plant, and manufacturing for very different classes of demand. Moreover, the organizations of the woollen and worsted trades differ as widely as their technical and marketing problems. The worsted trade uses mainly Merino and fine crossbred wools for its yarns, whereas the spinner for the woollen section uses the medium and lower grade wools, as well as the shorter staples rejected by the worsted trade.[1] About 75 per cent of the Australian clip consists of 'fine' wools, and Australia is mainly interested, therefore, in the worsted trade.[2]

So complete has been the dependence of wool manufacturing countries upon Australian supplies for decades that the annual sales held in the chief cities of the Commonwealth are now the world's main raw wool markets. Beginning in September and finishing usually in March, these auctions are the result of close co-operation among growers, buyers, and brokers in order to maximize prices by effective grading. The wool coming to sale is classified into types (Plates 31 to 33); and buyers can inspect bales displayed prior to auction and bid (Plates 36, 37) with confidence as to quality and staple. The advantages of a free market in preventing the accumulation of stocks and for determining the economic price were widely recognized. World War I disturbed this efficient organization for free marketing. From 1916 to 1924 the control of Australian wool was in the hands of the British-Australian Wool Realization Association. The chief changes after 1924 were the return to free marketing, and the expansion of woollen and worsted manufacture in countries largely supplied in earlier years by Great Britain. The imports of Australian wool into Japan, the expansion of mill consumption in Australia, and the general enlargement of wool use as prosperity grew after the war years, were all responsible for rising wool prices, as well as for widespread pressure to return to the freer pre-war methods of trade. The movement was interrupted by the economic collapse after 1930; and, in a world where most nations were planning for self-sufficiency, world trade was recovering only slowly when war again disrupted world economy.

1. After the wool is carded for the worsted trade it passes to machines which comb the fibres parallel and separate the long 'tops' from the short fibres known as 'noils'. The noils pass to the woollen trade, which uses many kinds of wool, mostly short in staple.

2. The distinction between 'fine' and 'coarse' wools is a very loose one. Counts of 60 and over would normally be regarded as fine wools, but many worsted manufacturers use counts as low as 40. Length of staple is an important consideration. Different types and different methods of combing have to be considered. Broadly, however, about 75 per cent of Australian wool is fine, in the milling sense of the term.

During World War II the normal methods of marketing were again abandoned, and a tight control of sale and export was established by the British and Australian governments. Owing to the bombing of European cities and to submarine warfare, large quantities of Australian wool which under normal conditions would have been shipped, were temporarily stored at appraisement centres. The main shipments during the war were to the United Kingdom, and to U.S.A. where they were held as a stock-pile or strategic reserve for the U.K. and U.S.A. governments. The figures of import into various countries for the war years are therefore misleading; and at the end of the war the volume of stored wool was very large.

The Empire Wool Conference of 1945 was called to study the situation created by the accumulation of these wool stocks during the war, and to recommend a practical method for disposing of them, concurrently with the sale of the new clips, in such a way as to preserve stable prices. As a result, a plan of disposals was recommended and adopted by the Australian government in the Wool Realization Act, 1945. A Joint Disposals Organization was set up for the purpose of buying, holding, and selling wool on behalf of the United Kingdom and the Dominions' governments, in order to determine the total quantity of old and new clip wool to be offered at any time; to prepare schedules of reserve prices at which it was willing to acquire wool; to lift from the market all new wool which could not be sold at these reserve prices; to hold and dispose of stocks as the agent of the governments concerned; to facilitate the sale of wool in every way possible with a view to stimulating demand and progressively to reduce stocks; and to resume as soon as possible marketing of wool by auction.[3]

One major objective of this scheme for disposing of surplus stocks is to prevent the wide price movements which have embarrassed growers and traders since World War I ended. In 1922/23 the average Australian price was 46 per cent higher than in 1921/22; in 1923/24 it was 30 per cent higher still, and in 1924/25 it rose by another 14 per cent, taking the average price of the clip to the record level of 27d. per lb. in the grease. In 1925/26 the price fell 39 per cent, and after a recovery in 1927/28 and 1928/29 it fell in the next two years by 37 and 18 per cent respectively, taking the price to 8·4d. in 1930/31. In 1933/34 a rise of 82 per cent from the depression level took place, followed by a fall of 38 per cent to 9·8d. per lb. in the next year. At the outbreak of war the price in Australian currency was 10·4d. per lb. In September 1939, the Imperial Purchases Scheme fixed the price at 13·4d. per lb. for the first three years of war,

3. J.D.O. is a private registered company of eight persons. Four represent U.K., two Australia, and one each New Zealand and South Africa. It operates through subsidiaries in the Dominions and recoups its operating expenses from equal contributions made by the growers and by the four governments. Its *modus operandi* is to allot the amounts of old and of new wool to be auctioned at not less than a minimum fixed price, below which it is ready to buy back all unsold wool. Owing to heavy demand and high prices this has so far seldom become necessary.

raised it to 15·5d. and maintained it at that level until auctions were resumed after hostilities ceased.

The Chairman of the Australian Wool Realization Commission, commenting on these fluctuations, said that

it was generally felt by woolgrowers that the stability afforded by the war-time conditions was of far greater value to the industry than were the marked fluctuations of the preceding twenty years. Some woolgrowers were commencing to look forward with apprehension to the discontinuance of the war-time price stability, and to the possibility that it would be followed by a period of unstable and perhaps low prices, aggravated by the accumulation of stocks of far greater dimensions than had occurred during the previous world war.[4]

The stocks of Australian wool held by the Joint Organization at its inauguration in July 1945 amounted to 6,890,000 bales, increased by the ensuing clip to 9,817,000 bales. Sales progressively reduced stocks until by the end of June 1947 the carry-over of Australian wool was 3,076,500 bales (about 954,000,000 lb.) and that of the whole Organization (which covers South African and New Zealand clips) was 4,514,800 bales (about 1,400,000,000 lb.). The scheme of orderly marketing, adopted in the belief that the total amount available at the end of World War II was not excessive in the light of depressed world needs and the necessity for working reserves for manufacturers, has so far been successful.

A critical focus of issues affecting the future of wool is to be found in the tariff of 34 cents a pound imposed by the U.S. Administration upon imported scoured wools, not in the interests of domestic manufacturers, but of home growers. Wool-growing is not an efficient industry, economically or technically, in U.S.A., where, between 1942 and 1947, sheep numbers declined from 56 to 44 millions, and wool production (in the grease) from 450 to 350 million lb. American costs of production are high, and growers are more interested in raising fat lambs for meat than in maintaining flocks for wool. The total income to growers from fat lambs in U.S.A. is more than double that for wool, and the tendency is to shift away still further from wool-growing to meat production.

Faced by demands for assistance from the growers, and with the difficulty of clearing the stock-pile of wool in U.S.A., the Administration in effect raised the home price for one pound of scoured wool to $1·09 in 1946, whereas Dominions' wool was purchasable in the world market at 75 cents, a difference of 34 cents, i.e., the tariff rate. The added primary cost to the mill-owner for wool consumed, including 400 million lb. imported despite the tariff, was about $136m., or more than the total value of the 350 million lb. of home-grown wool.[5] The added cost upon finished apparel arising from the tariff-inflated value of the raw material raised the total excess cost much higher. In these circumstances, consumers and manu-

4. Primary Producers' Conference, Colac, Vic., 1946.
5. See article in *Fortune*, January, 1947.

facturers in U.S.A. have for years agitated for lower duties; and, clearly, North America should be a leading market for wool. Reduction of the U.S.A. tariff on wool following upon the Geneva Conference in 1947 constitutes justifiable assistance to world trade in an important commodity.

3. CHANGES IN THE DEMAND FOR WOOL

The growth of woollen manufacturing in what were former British markets helped the Australian fine-wool grower by providing greater competition at the auctions. At the same time, the world-wide shift from worsted to other fabrics, the swing from heavy to lighter weights of cloth, the competition of artificial fibres, the use of central heating, and the increased use of motor vehicles brought in new elements of instability both for the wool-grower and for the manufacturer. More recently, however, another element of instability is likely to affect the demand for wool in common with that for most other commodities. This new factor is the alteration that has taken place in the relative value of currencies owing to inflationary policies pursued in most countries as one method of financing war-time and post-war expenditure.

Inflationary disturbance of the cost-structures of all industries, e.g., rising costs of labour and materials, affect differentially the over-all production costs of all types of fibres. This differential movement in production costs will affect, for better or worse, the competitive position of wool in relation to its substitutes; and new techniques of mixing wool and artificial fibres will complicate the position still further. Despite its traditional stability, changes in the elasticity of demand for each type of fibre are likely to affect the competitive strength of wool to an extent that is impossible to predict. Wool-growers' returns are rising, but many of their costs are rising with equal rapidity. Moreover, ability to control costs in the production of artificial fibres is likely to be greater than in the production of natural fibres, since higher efficiency in factory production is more easily attained than higher efficiency in pastoral management. And beyond these are the influences of old custom and new fashions which will conflict interminably. Fashion has played its part both in steadying demand, as, for example, by the increased demand for fine wools for knitted goods, and in making demand more capricious, as exemplified by the intermixture of wool with cotton, rayon, and the newer chemical fibres. It is to the changes we have noticed that some of the uncertainties of markets and prices are traceable.

In this way uncertainty for the future of woollen manufacture is communicated to the pastoral industry. The outlook for both sheep station and factory depends upon these changing elements of demand. Manufacturing authorities in England have urged that costs in woollen manufacture should be reduced by rationalizing the industry—unified buying, larger producing units, elimination of uneconomic units and of alleged 'useless'

middlemen. Wool-growing authorities in Australia have urged that costs could be reduced by better station management and by organized marketing, and that prices could be maintained by the better management of sales. But without extensive socialization of industry, such rationalization, either at the producing or consuming end, is difficult, and in the meantime other changes are afoot. Not the least significant of these is the extraordinary growth of the ready-made clothing industry. What the effects of all these changes will be upon consumption and upon the returns for both the primary and the secondary producer cannot be foretold.

Further discussion upon these lines will not help our main purpose. Suffice to say that, for the world as a whole, the net result of changes since 1930 has been shown mostly in fashions foisted upon consumers by manufacturers and advertisers, on the one hand, and in governmental management of trade and consumption policies, on the other. What the ultimate effect of the shift towards manufacturing for home markets rather than for export markets will be, no one can yet say. Neither can we predict how far movements to wear less and lighter clothing will go, or how other developments, e.g., air-conditioned buildings, will effect the woollen trade. Adaptation to new conditions is always uncomfortable, and it is clear that no assurance of stable conditions can be given wool-growers, especially in a situation where neither monetary movements nor the competition of substitutes could be predicted. Any assessment of the place of wool in the scheme of Australian land use in the future is thus extremely complicated. It is scarcely too much to say that the prosperity of Australia will continue to be dominated by the world demand for wool, the product of the one great unsheltered industry, more than by any other factor.

These considerations lead naturally to a discussion of those broad changes in ways of living which, first as a response to science and invention, and then as a response to fashion and comfort, gradually or abruptly affect the demand for commodities entering into world trade. Although different kinds of wool are produced for a multitude of specialized uses, we are mainly concerned with the demand for wool as material for clothing—apparel wool as it is often called.

Clothing, apart from its secondary decorative aspects, is a response to primitive conditions. It is an attempt to control climate at the body surface. But the trend in modern cities is to attempt to control climate by different methods altogether, i.e., by the regulation of air temperature in enclosed spaces, broadly known as central heating or air-conditioning. Before World War II, an increasing proportion of the great metropolitan populations worked and lived in buildings or travelled in vehicles where temperature was controlled. In many of the great cities of North America and Europe the more primitive response, i.e., the demand for thick woollen clothing, was falling. Demand of this sort for wool is not, of course, likely to decline for

many years in the state of present housing needs, and it is not easy to predict the nature of clothing demands or the persistence of government control of distribution. But higher prices in the 1946-47 season, which resulted as much from fears of currency inflation as from higher demand, and Europe's need for clothing, have obscured the issue for the time being.

If we turn to the secondary (or decorative) demand, it may be that rising standards of consumption in Europe and North America may express themselves in a preference for more but different and lighter garments. The fine wools of the Merino type in that case may be expected to retain or even enlarge their market, and again the implications for price and land use are significant. The fact that the demand for fine counts tends to keep the price for this group relatively higher than that for coarse wools is important. What is probable, of course, is a parallel but uneven development of both types of demand.

For the reasons here broadly sketched, the question of the future capacity of the world to absorb wool is thus vital to the study of land utilization in Australia. But, although this question is fundamental, it is improbable, even with the utmost skill in statistics or with the maximum knowledge based on the experience of the past, that the long-term trends of wool consumption can be predicted with any degree of accuracy.

4. ARTIFICIAL FIBRES AND THE DEMAND FOR WOOL

The future of wool lies somewhere between two extremes, represented by complete displacement, on the one hand, and a strong swing back to customary use on the other. The pressure of invention, the competition of artificial fibres, and self-sufficiency policies in countries which formerly used wool are, however, likely for many years to produce doubts as to future prices, which may in turn generate some uncertainty about types of land use in Australia and other wool-growing countries. The increase in competition by substitutes is shown in table on p. 136.

Successful competition with wool by artificial fibres rests, and is likely to rest, upon lower cost of production. That fact, and the availability of the basic materials from which they are made, explain the enormous growth in the manufacture of rayon and staple fibres in the last two decades. The annual output of all types of artificial fibres is already equal in bulk to that of wool. Allowing for over-estimates of output and for relaxation of war-time urgencies which had forced up the production of substitutes for wool and cotton, there is still no reason to expect anything but a continuance of the recent rate of growth in production. The status of wool is not endangered because of the superiority of its new competitors in those characteristics which distinguish wool, but because they have their own peculiar advantages which make them attractive for some purposes for which

World Production of Rayon (Artificial Silk) Fibres
(Rayon filament and staple fibre*)
Millions of lb.

	1935	1936	1937	1939	1946
Europe—					
Italy	153	196	263	309	94
Germany	136	194	345	601	108
Great Britain	122	143	152	179	183
France	66	66	78	72	102
Holland	21	22	24	24	22
Belgium	14	15	18	15	45
Poland	13	13	17	22	19
Switzerland	8	11	12	12	37
Czechoslovakia	6	7	9	6	21
Spain	8	6	3	5	30
Other Countries—					
Japan	238	325	511	540	30
United States	262	290	341	380	854
Canada	13	14	17	14	22
Brazil	4	5	7	15	24
Other countries	17	24	35	60	81
Total	1,081	1,331	1,832	2,254	1,672

*Rayon yarn is produced by treating cellulose obtained from either purified wood pulp or cotton linters with different chemicals to form a solution which is then forced through a 'spinneret' (a metal jet with many tiny holes) and solidified in the form of filaments. Rayon is used in two principal forms: (1) continuous rayon filament (often referred to as simply rayon filament or rayon yarn); and (2) rayon staple fibre which is produced by cutting filament into desired lengths to be spun on the cotton, wool, and spun silk systems.

Computed from: *World Fibre Survey*, F.A.O. publication, Washington, August 1947.

World production of cotton, wool (greasy), silk, rayon filament and staple fibre is summarized in the table below.

World Production of Cotton, Wool, Silk and Rayon
(Millions of pounds, and percentage of total production of four groups of textiles)

Year	Cotton (Net wt.)		Wool (Greasy)		Silk (Estimated)		Rayon (Filament and Staple Fibre)		Total	
	m. lb.	%	m. lb.	%	m. lb.	%	m. lb.	%	m. lb.	%
1924-28 Average	12,827	77	3,523	21	112	1	251	1	16,713	100
1934-38 Average	14,280	77	3,799	20	123	1	410	2	18,612	100
1945-46 Season	9,871	65	3,573	24	35*	—	1,672*	11	15,151	100

*Calendar year 1946.

Computed from: *World Fibre Survey*, F.A.O. publication, Washington, August 1947; and *League of Nations Statistical Year Book*, 1932-33.

they may displace wool wholly or in part. The displacement of wool, if it occurs, will be made easier if the purchasing power of the major currencies continues to fall, and as a larger volume of production enables costs of production to be reduced more rapidly for synthetics than for wool.

Artificial fibres as now produced fall into two main classes which may, somewhat inaccurately, be called the cellulose and protein groups. The *cellulose* group embraces fibres such as rayon and its variants, the filament of which is formed of cellulose produced by two main methods (viscose and acetate) from wood-pulp or cotton linters. Although it is cheap in production, its composition and method of manufacture prevent effective reproduction of the characteristics of wool; and textiles made from cellulose compete more readily with silks or fine cottons than with wool. The *protein* group, on the other hand, is more likely to duplicate the characteristics of wool but to possess a smaller advantage than rayon in comparative cost.

Protein is the generic name given to a group of chemical substances of a highly complex nature. A protein, physically, is a linkage of a great number of chemical groups; but, until it is known how this linkage is brought about, the properties of protein will not be thoroughly understood. It is sufficient to say here that filaments are produced by physical rearrangement of particles from:

(a) *Natural protein* obtained from peanuts, skim milk, feathers, and other organic substances. The process is relatively simple; but the raw materials are expensive and have alternative uses, so that natural protein fibre enjoys little advantage in cost of production.

(b) *Reproduction of protein structure*, e.g., nylon, obtained chemically from relatively expensive raw material such as coal or petroleum. The whole process is more complex; and the resultant filament is as costly as wool but, for some uses, either easier to work or superior in use. The real challenge to wool is likely to come from the improved products of this group, especially since monopoly control and large operating capital can impose high standards of quality and technical treatment and can promote highly effective advertising.

It should be understood, however, that accurate comparison of the costs of production or of wholesale prices for artificial fibres and wool is surprisingly difficult; but it would seem that, weight for weight, rayon for example is marketed at about 60 per cent of the price of clean wool in U.S.A. The price advantage for other types of synthetics is much less. Any tendency for synthetics to displace wool would, however, be greatly assisted by the revival of self-sufficiency policies in countries which have been major wool markets. No commodity would have more to lose than wool through restriction of free trade or by inflation in countries which import wool regularly in quantity, because either development would lower the return to the Australian

wool-grower at a time when internal costs seem certain to rise steadily for some time ahead.

5. WORLD PRICES AND AUSTRALIAN COSTS

There is, however, a second question of great importance, which concerns cost of production. It is clear that for wool, as for all other primary products, anything that can keep prices down to as low a level as is economically possible will be a powerful stimulant to consumption in other directions. It would seem, therefore, that the problem for the Australian pastoralist is the difficult one of reconciling the conditions of a protectionist regime with those of a world economy. If it were not for world inflation and consequent rising prices in world markets, this difficulty would almost certainly have entailed a series of price-cost adjustments throughout the Australian economy.

Stated in its simplest form, all this means that the future of wool production in Australia depends upon the price for wool in world markets and the cost of production in Australia, on the one hand, and on the ability of wool manufacturers to produce new and more attractive fabrics, on the other. The new methods of treating sheepskins to resemble high-grade furs, the new uses to which wool is being put in carpet making, and the soft and delicate texture in a wide range of new woollen fabrics have opened up fresh and important consumer territory for wool in countries of high purchasing power.

High prices and the profitability of the wool industry after 1920 prevented a swing from pastoral to agricultural uses in the relatively few areas where the alternative use of the land was feasible. The general and severe fall in prices after 1930 not only removed this condition, but stimulated the production of artificial fibres, especially in countries such as Germany, Italy, and Japan which were aiming at self-sufficiency in textiles. Continuing technical improvements in the production of artificial fibres are bound to maintain a persistent downward pressure on the price of wool, and propaganda campaigns for wool use are not likely to alter such a fundamental trend.

The whole of economic history shows that the only sure and permanent way of stimulating and holding demand is to make economically possible a lower level of prices. It will never be possible to reduce the costs of producing wool to levels which will allow it to compete with artificial fibres of the cellulose type; and it may not even be possible to compete on a price basis with the protein types. Moreover, technical improvements in production of synthetic fibre are accompanied by great efficiency in distribution. A traditional and possibly expensive system of buying and distributing wool which has grown up through the last century of trade in 'the staple' has now to compete with a new and efficient system, not only of producing the new fibres,

but of inducing their use. More efficient low-cost methods of distribution of rayon fibres have gone a long way to compensate the impoverishment of large sections of the world's people who were formerly users of wool.

If such competition becomes extremely acute, the effects will prove to be of two kinds:

(i) a pressure for increased efficiency from within and without the wool-growing industry; and

(ii) the search for alternative uses for some at least of Australia's pastoral areas.

The pressure for greater efficiency from within the industry is nothing less than a struggle for survival against the forces we have examined. Uncertainty as to the price of their raw material is a definite handicap to manufacturers in any industry. The wide fluctuations in wool prices since 1914 have already been discussed. The way in which these are carried through the chain of manufacture is seen in the following table.

Indices of Prices for Wool in U.K.

	Wool	Tops	Yarns	Group Average
July 1914 . . .	100	100	100	100
Highest post-war . .	368	403	592	450
Lowest post-war . .	49	61	81	64
January 1937	116	121	136	124
November 1937 . .	91	93	113	99
August 1938	79	85	102	89
March 1947 . . .	159	158	224	180

Source: Weekly Wool Chart (Bradford).

N.B. These figures should be read with caution, since the U.K. prices on which they are based understate the prices for tops and yarns in other world markets. The general wool index is reasonably accurate.

The Joint Disposals Organization has set a floor to wool prices for a period; but, when J.D.O. ceases to function, growers will be required to decide whether they desire free sales at world prices or some scheme which will guarantee minimum prices. A similar issue had to be faced concerning the future of B.A.W.R.A.,[6] the prototype of J.D.O. after World War I, and growers voted against its continuance. Australia's staple industry may yet be an applicant for subsidy under a price stabilization scheme guaranteed by the Federal government, or for a system of marketing supported by a valorization. Whatever is done is likely to be a response to a fall in prices from the high levels which prevailed after hostilities ceased and J.D.O. took over. The outstanding fact is that, if world consumption declines or wool prices fall to a relatively low permanent level, no scheme of valorization will do more than postpone inevitable, and possibly painful, adjustments in the wool industry.

6. British-Australian Wool Realization Association.

CHAPTER VII

THE WHEAT INDUSTRY

1. The Course of Development of Wheat Farming in Australia
    (a) Development up to 1920
    (b) Experience between the World Wars
    (c) From 1939 onwards
2. The Australian Wheat-growing Areas
3. Quality and Marketing

CHAPTER VII

THE WHEAT INDUSTRY

1. THE COURSE OF DEVELOPMENT OF WHEAT FARMING IN AUSTRALIA

FIG. 43 shows the approximate boundaries of the wheat belt in Australia at the present time. The limits of that belt have been discovered and defined by the economic experience of individual farmers working under their own particular conditions of soil and climate. The inner boundaries of the belt are also boundaries for the economic production of other winter or spring-grown cereals. It is generally true that barley or oats could be grown just as effectively throughout the present zone of wheat production, and in some areas a higher yield per acre would actually be obtained. However, barley and oats are less valuable than wheat for export purposes; and, as the cost of transporting grain from the farmer's wagon to the granary in London is from 1s. 3d. to 1s. 6d. per bushel, when shipping freights are low, and up to 4s. 6d. when they are high, it follows that farmers concentrate their efforts on producing the grain which brings the highest returns.

(a) DEVELOPMENT UP TO 1920

The history of the characteristic evolution of land utilization given in chapter II contained a survey of the factors which led to the development of the wheat industry. The development of wheat acreage was set out in Fig. 6.

South Australia (Fig. 48) had been a wheat-producing state since 1843. The farmers of the fertile regions of the Adelaide plains and the Lower North Division soon discovered the system of agriculture most suited to the soil and climatic conditions, and their efficient application of this knowledge and their proximity to the seaboard enabled them to develop their wheat-growing industry rapidly. The desire among wheat farmers for more land caused a steady extension of wheat-growing into the Murray-Mallee areas, and also across Spencer Gulf to Eyre Peninsula and along the coast of the Australian Bight. Victoria (Fig. 51), profiting by a considerable migration of wheat-growers from South Australia, had developed the better soils of its Wimmera and Southern Mallee in the 'nineties, by which time railways had been constructed. Fresh areas were opened farther to the north in the less reliable parts of the state during the period 1900-14, so that during these years the Victorian wheat acreage was usually greater than that of any other state.

In New South Wales, the state with the largest population, wheat-growing had been somewhat neglected until the general depression of

the 'nineties. Subsequent improvements in machinery, wheat varieties and methods of cultivation stimulated a general overhaul of farming practice. This state became a constant exporter of wheat after 1898. Slowly farmers realized that some of the moister areas previously concerned solely with keeping sheep could grow wheat with greater profit.

In Western Australia, the discovery of gold at Coolgardie in 1892 had led to the development of railways over the plains to the east of the ranges (Fig. 5). This advance had brought new areas suitable for wheat into better communication with the coast, and, from 1906 onwards, steady expansion occurred as the profitable nature of this type of farming was gradually realized. In Queensland, the limited area of country suitable for wheat-farming, and the speculative nature of this crop under summer rainfall conditions, prevented any notable expansion.

The season 1914-15 was marked by a severe drought, and it became necessary to import about 6,000,000 bushels, chiefly from the Argentine, in order to carry on in the following season. A special war effort was made in 1915-16, and a record area of 12,484,500 acres was sown to wheat. This large acreage was only obtained by replanting areas which had been sown in the previous year, and by abandoning, for the time, the practice of fallowing. The exigencies of the war period made it necessary for the Commonwealth government to take over the sale and distribution of the whole crop, less farm requirements. Shipping was scarce and there was great congestion of grain at the main ports during the remainder of the war. The government made advances to farmers for the crop of 1915-16, and in later war years further disbursements were made as the produce of the year was sold. There were considerable delays in the subsequent payments, which did not tend to encourage wheat production, especially as the war had caused a scarcity of labour and a rise in the general price level of farmers' requirements. The result of these various influences on wheat profits was seen in the decline in planted acreage which took place in every state, until in 1919-20 only 6,419,000 acres were sown.

Marketing difficulties prevented the price of Australian wheat from reaching the height which was attained in Europe and North America towards the end of the war period, but the acute world food shortage which prevailed at that time in many European countries resulted in an average f.o.b. price at Australian shipping ports in 1920-21 of 9s. per bushel (Fig. 44). Under such circumstances wheat was very profitable, and many farmers sowed increased acreages, so that the area under the crop showed a marked rise in 1920-21, especially in New South Wales.

(b) Experience Between the World Wars

This temporary strength of the wheat markets was only part of the general rise in price level of almost all commodities. At that time it was

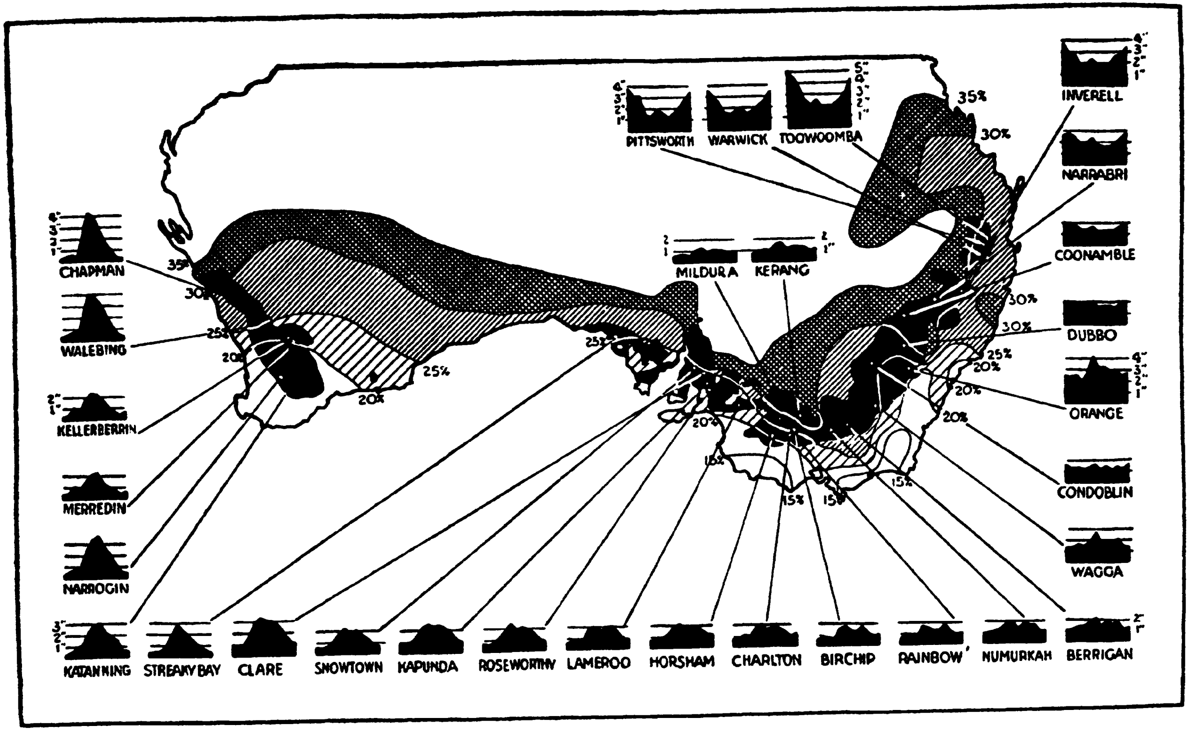


Fig. 43. The Australian Wheat Belt

The wheat belt is shown in black; most of it lies between the 10" and 20" isohyets of average annual rainfall. The distribution of the rain for each month of the year is shown on the silhouettes for the selected stations. The shaded portions of the map show the annual percentage rainfall variability in zones (after the late H. Barkley).

generally assumed that a new level of prices had been reached, and that world economy would adjust itself about this new level. Simultaneously large numbers of returned soldiers were repatriated, and governments were faced with the problem of finding suitable occupations for them. In Australia, as well as in other countries, land settlement was regarded as the best solution of the difficulty, and many repatriated men decided to become wheat farmers. At the same time, the British government made arrangements whereby some of its returned soldiers could take up land in the Dominions and colonies. Extensive schemes of land settlement were, therefore, set on foot in every

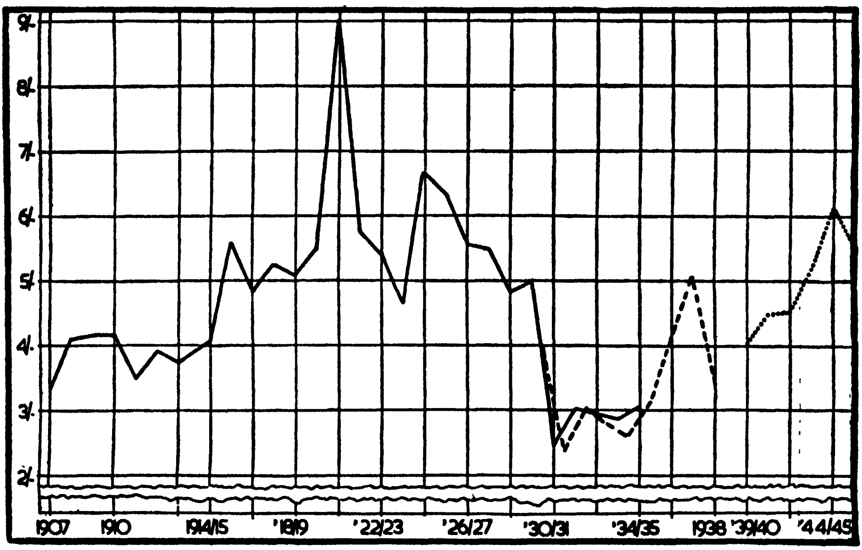


Fig. 44. Australian Wheat Prices

Continuous line = Australian wheat export prices in the principal markets of Australia.
Broken line = Weighted average of shippers' limits for growers' bagged lots Sydney, Melbourne and Adelaide.
Dotted line = War-time pool prices for bagged wheat converted to an f.o.r. ports basis.
Source: *Commonwealth Year Books* and information given by the Australian Wheat Board.

mainland state. In Western Australia, particularly, the expansion of the wheat belt, which had begun before the war, was accelerated, and many new districts were opened, mostly in regions of lower rainfall. Similarly, in the other mainland states, certain areas of Crown land which had previously been either pastoral or covered with scrub, were transformed into wheat farms. In addition, in each state, authorities vested with the duty of administering returned soldier and closer settlement schemes purchased large estates which had been largely devoted to grazing, and, where these were adjacent to the older parts of the wheat belt, they were subdivided and resold as wheat farms.

These developments were largely responsible for the expansion in the wheat acreage which occurred during the period 1920-21 to 1927-28. The gradual nature of this increase is accounted for by the fact that the process of developing a wheat farm in a new area is a slow one, and the full effect of developmental policies is not immediately felt. The year 1927-28 was very dry in the wheat belt of South Australia, Victoria and New South Wales, and many crops failed. In the following season numbers of farmers resowed those parts of their farms on which production had been light during the preceding year. In 1929-30 the economic crisis developed, and governments in several states made appeals to farmers to grow more wheat in an attempt to ensure a surplus of production which would help Australian governments to meet their commitments overseas. The Commonwealth government formulated a scheme for wheat marketing which involved the establishment of a *compulsory* wheat pool embracing all states. This scheme, which provided for a guaranteed price of 4s. per bushel at railway sidings, was embodied in a Bill, but it failed to secure the approval of the Federal Parliament. The crop harvested (213,594,000 bushels) was a record in bulk, although not in yield per acre. The circumstances which led to this record acreage and production were, therefore, exceptional, and a prolonged period of high prices would have been necessary to raise the Australian wheat acreage much over 18,000,000 acres under normal circumstances.

In 1931, Australia found herself with a very large crop on her hands, and with the world wheat price at its lowest level for many years. As a result, many wheat farmers were in a desperate financial position. The states which had experienced the drought in 1927-28 had already found it necessary to provide special assistance to farmers because of the large number of men who were at that time establishing themselves on the land, and who had not had an opportunity of accumulating any financial reserves. Early in 1930, a general moratorium was enacted in New South Wales; and, early in 1931, this example was followed by Victoria, South Australia and Western Australia. As this measure was found to be inadequate, further relief and debt adjustment Acts were passed in each of the states mentioned. In addition, the Commonwealth government, probably realizing its moral obligation in view of the rejection of its Bill for a guaranteed price per bushel, and in response to pressure from the states, agreed that some assistance from government funds was necessary for the wheat industry. During the two following years the Commonwealth government made a further allocation to wheat farmers for the same purpose. Since, even with the addition of the Commonwealth bonuses, the price situation (Fig. 44) remained unsatisfactory, the farmers in many districts became restless. Finally, at the beginning of 1934, the Commonwealth set up a Royal Commission to investigate the economic position of the industry; and, in view of certain criticisms which had been made with reference to the price of flour and bread, the ambit of the

enquiry was enlarged to include the milling and baking industries as well. In July 1934, the First Report of the Commission was published. This report stated that about half the wheat-growers could produce wheat at the cost of about 3s. per bushel at their local sidings, and that the industry as a whole was in a state of drift. The Commission found the number of wheat holdings in the Commonwealth was 62,174, but about a third of these were small farms cropping less than one hundred acres. The following table gives the relevant figures.

Wheat Holdings

State	Season 1932-33	
	Total Number of Wheat Holdings	Number of Holdings Cropping over 100 Acres of Wheat
New South Wales	17,892	11,002
Victoria	18,303	11,238
South Australia	14,248	10,800
Western Australia	9,804	8,267
Queensland	1,927	500
Total	62,174	41,807

Source: *Second Report, Royal Commission on Wheat, Flour and Bread Industries*, 1934-35 (Govt. Printer, Canberra).

These figures show the large proportion of the areas held by farmers with small acreages, particularly in Queensland, where on some farms wheat-growing is carried on in conjunction with dairying.

The Commission recommended that the Commonwealth government should continue its assistance to the industry, and that the sum required during 1934 would be £4,000,000, assuming a price of 3s. per bushel at Australian ports. A supplement to this report appeared in November 1934, and methods for distributing the £4,000,000 were suggested.

The Second Report, presented in February 1935, covered the whole range of problems confronting the industry, and presented a large mass of information relating to costs of production in various districts. A detailed survey of the debt position of the industry was carried out, and this indicated that the total indebtedness of wheat farmers was of the order of £150,000,000, of which £130,000,000 was 'secured'. A study of the position of a representative sample of 524 farmers indicated that about 40 per cent were in a sound financial position, and 26 per cent could be rendered financially stable if they were given assistance either by means of a reduction of interest or of the amount of their capital indebtdness. The remaining 34 per cent were found to have production costs in excess of 3s. 2½d. (excluding interest) per bushel f.o.r. at ports; and, consequently, unless the price of wheat, plus whatever government assistance could be given, were to exceed

that figure, it was of little use their continuing wheat-growing under their present methods.

The low prices received caused a contraction of acreage under wheat to 11,957,000 acres in 1935-36, during which season further assistance was given by the Commonwealth to the wheat-growers. In 1936-37 world prices for wheat rose, and the acreage under crop increased. In 1938, a large world surplus of the grain having again accumulated, the price fell, and further assistance became necessary. The total amounts provided for the industry, by way of bounty or relief, during the decade 1931-41 are set out in the following table.

Sums Paid to Wheat-growers as Bounty or as Relief

Season	Total £A	Per Bushel d.
1931/32	3,429,314	4·32
1932/33 ..	2,000,000	2·24
1933/34 ..	3,053,000	4·13
1934/35 ..	4,040,608	7·27
1935/36 ..	1,915,869	3·19
1938/39 ..	1,808,693	2·79
1939/40 . .	2,486,067	2·83
1940/41 ..	2,468,593	7·20

Computed from *Production Bulletins* (Commonwealth Bureau of Census and Statistics).

(c) From 1939 onwards

The year 1938-39 saw a partial drought in Victorian wheat areas, but in 1939-40 the total crop was 210,487,000 bushels with an exceptionally high yield of 15·04 bushels per acre. World War II had started, the Commonwealth government under its war-time powers had taken control of the marketing of the crop, shipping was scarce, and the problem of storing such a volume of grain became acute, for the silo systems are designed for transporting rather than for long-term holding. Special storages in enormous bulkheads were constructed in some places, in others stacks were used. In this and ensuing years the deterioration of the grain through attacks of insects became a special problem, but as the result of prolonged scientific investigation the loss was reduced to relatively small proportions.

Faced with a wheat surplus which might become unmanageable, attempts were made to restrict sowings, and acreage was rationed at previous levels. The farmers, beginning to feel the shortage of labour due to war enlistments, were ready to agree to these proposals. Further, the scheme for altering the system of farming in the more risky marginal areas by growing less wheat and keeping more sheep was making progress and considerable areas in Western Australia, South Australia and New South Wales were readjusted on this basis.

The season 1940/41 was a drought in the chief wheat-growing areas. The average yield per acre fell to 6·5 bushels and the total crop was 82,233,000 bushels, the lowest for twenty-two years. This gave some respite to the storage position, but the two following years were normal in yield and a great surplus again accumulated, amounting to 154,000,000 bushels on 30 November 1943 when the next crop was about to be harvested. 1943/44 was a poor season in Victoria and Western Australia and by this time large quantities of wheat were being fed to livestock for the production of dairy products. During 1944 the war situation improved and it was possible to export more and more wheat and flour. 1944/45 was a major drought except in Western Australia and the northern parts of the wheat belt. Reserves of the grain in the other states were used up and shipments had to be made to Victoria from the west, where the railway transport system, enfeebled during the war effort, was scarcely able to handle the traffic. By 30 November the carry-over had been reduced to 11 5 million bushels (including flour). Fortunately, the crop of 1945/46 was normal and the situation was saved. Demands on the Australian supply for India, the Middle East and Europe were now pressing, but unfortunately the growing season of 1946 was not a good one and for a long time the crop was uncertain; finally, it was a very poor one in all the northern areas. Consequently, Australia was not able to do as much as might normally have been expected in relieving the overseas position.

In the meantime the price had soared in sympathy with the very high prices being charged for wheat in North America. Shipping freights to Europe were now over 3s. per bushel, so the Australian export price did not reach the levels in America.

Throughout the war period discussions took place on schemes for stabilizing the industry in the post-war period. The farmers' leaders now seem to realize that any scheme of price guarantee by the government must be accompanied by some mechanism which will restrict output when stocks accumulate. Whether the bulk of the farmers themselves are of this opinion is another matter. It is certain that some political groups are very hostile to any such restraint. Naturally other argument centres about the minimum price which should be guaranteed and the allocation of any surplus which is realized. The farmers are worried about the rising costs of their machinery and other requisites, while the government is anxious to retain control of the extent of its commitments in future periods during which developments are uncertain.

Whatever happens in the immediate future, it is safe to forecast that, failing some international agreement on world wheat policy, the events of 1930-35 will recur as soon as any large accumulation of world stocks of the grain reappear, for there is no reason to suppose that the long-term potentiality of the world's farms to produce wheat has declined owing to

the war. The nature of international agreements is specially important to Australia. Her ratio of stocks to production needs to be higher than in most other countries owing to droughts such as that of 1944/45. The method of restriction of output is also important. So far this has been tried on an acreage basis, but this would be difficult to enforce in peacetime when labour and phosphate were not controlled.

2. THE AUSTRALIAN WHEAT-GROWING AREAS

A wide variability exists between wheat-growing methods and wheat-growing efficiency in the various parts of the wheat belt. In order to appreciate these differences, and as a means of presenting a general description of the pattern of agriculture within them, it is necessary to traverse the districts in some detail. Even a brief survey must make special reference to the soils and climate of different areas, and to the extent to which subsidiary forms of production may lend an added stability to agriculture.

A comparison of the soils map of Australia (Fig. 25) with the distribution of the present wheat areas shows that the modern Australian wheat belt lies entirely outside the zone of leached soils. In this zone there are many areas on which wheat could be produced by methods of soil management similar to those employed in England; but this would involve an intensification of the agricultural system, and in many cases higher costs, while quality of the grain would be low. As the price received for the crop in Australia would be the British price, less cost of transport, it is clear that such a type of production on an area of this class could not be economically stable, except where soils are specially favourable. These high-grade soils are by no means abundant in the leached soil zone, and usually carry effective pastures. They give a higher cash return when used for grazing than they would under a cropping system.

The climate prevailing over most of the Australian wheat belt requires the employment of special methods that have been worked out in great detail over the last half-century, and are now reasonably efficient for the production of the crop. They involve the use of large-scale machinery and the harvesting of the grain by machines which reap and thresh simultaneously (Plates 17 and 40). This can only be effective and cheap in a dry climate where the crop dries out in the ear and with varieties which strip easily. The ease of mechanical harvesting in a dry climate was mainly responsible for establishing the wheat belt in its present position. With this goes a soil of fair average fertility, needing only one fertilizer, namely superphosphate, which is generally essential for good yields. Nitrogenous fertilizers are not needed under the almost universal system of a period of bare fallow before sowing; however, this practice cannot succeed indefinitely unless leguminous plants are allowed to grow at some stage. Potassium is generally abundant; and as

the stubble is either burnt or ploughed in, only those nutrients taken off in the grain are lost.

Wheat, as grown in Australia, has either an autumn-winter-spring or a winter-spring period of growth. In most areas the harvest is completed before midsummer, and it is never more than a month later in any district. In Western Australia and in the southern parts of the eastern wheat belt the main growth occurs in the period of maximum rainfall; and the onset of the dry, hot summer, coupled with the relatively small amount of spring precipitation, determines the end of the growing process. In the more northerly sections of the wheat belt in New South Wales, and also in Queensland, the maximum rainfall has a summer incidence. Here the growing season of the crop must be limited to minimize both the danger of serious epidemics of rust and also the liability to weather damage in years when rain falls during the harvest. This preliminary consideration of the soil and climatic conditions prevailing in the wheat areas indicates that, in some ways, Western Australia is the simplest section with which to commence a more detailed account.

Western Australia (Fig. 45)

In Western Australia the outstanding feature of the soils of the wheat belt is their great variability, sometimes within relatively narrow areas. The broad features of these soils have already been referred to in chapter III (p. 55). They consist of ironstone types and sand plains, believed to be residual from a former wetter climate, and loams of fair fertility derived directly from the country rock. The harsh Acacia scrub known as 'wodjil' which forms the natural vegetation of the ironstone areas consists of hard-leaved or thorny shrubs, whose only distinction is their floral magnificence in the spring. Agriculturally, the soil on which they grow is deficient in nutrients, and physically intractable. It seems unlikely that wodjil areas will ever be cultivated.

The sand plain areas are estimated to cover ten million acres, largely in the wheat belt (Plate 38). They differ considerably from place to place, and their natural vegetation is usually described as heath and sclerophyll scrub. In their unimproved state they are devoid of useful grazing plants, and before they can be brought into effective agricultural, or even pastoral, use it is necessary to build up their fertility, certainly as regards both phosphate and nitrogen. After this has been done over a period of years, they develop into low-grade wheat soils.

The best wheat soils of the state are the light to heavy loams, the relatively new soils which are sometimes found extending unbroken over considerable areas, but are more frequently interwoven with patches of sand plain and ironstone. The discontinuity of these soils has a double disadvan-

tage. It results in a wider distribution of the farming areas than would otherwise be necessary, so that transport costs are increased, and the organization of all social services is more expensive owing to the dispersion effect. If it be assumed that a reasonable area for an individual farm is a thousand acres of good wheat-growing soil (and this has been the policy of the state Lands Department in recent years), then for effective land use it may be necessary to include three times that area within the boundary of a single holding. It is unsound practice to leave the sand-plain areas untouched, because they readily become the breeding-ground of rabbits, while the grazing which they yield in return for enclosure is of limited value in their unimproved state. It is often difficult to obtain individual paddocks in which the soil is uniform; consequently the effective timing of farming operations is difficult, while the local variations also offer obstacles to the efficient use of large-scale machinery.

The original vegetation on the better soils of the wheat belt, and on some parts of the sand plain, consisted of various species. In the western part York Gum (*E. foecunda*, var. *loxophleba*) and Jam (*Acacia acuminata*) are the main types; to the east, Salmon Gum (*E. salmonophloia*) and the Gimlet (*E. salubris*). This latter type of woodland was fairly easy to clear, because the trees burn right down to the roots. Other areas, where Mallee scrub was the dominant vegetational type, were more difficult because the Mallee is more resistant to fire, and has a far greater tendency to sucker. In general, however, obstacles to clearing were less in the Western Australian wheat belt than was the case in parts of similar rainfall in the eastern states.

The wheat belt of Western Australia ends sharply to the north of Geraldton, owing to the way in which the rainfall decreases rapidly away from the coast. Fig. 43 shows that, in this district, the variability of the rainfall from year to year is high. The inset silhouette, month-to-month rainfall chart for Chapman, indicates the fact that the average rainfall is largely confined to the period from May to October, while the summer is long and dry. This restriction of the rainy period to a relatively narrow season is generally characteristic of the whole of the wheat-growing belt of Western Australia, especially of its eastern margin. This factor imposes a definite limit on the capacity of the farms to carry sheep effectively. Another complication in the northern region is the lack of good holding ground for water supplies and the necessity for obtaining water by boring. Flocks are, however, frequent on the better watered areas. The limited duration of the rainy priod also results in a need for wheats with short growing periods and capable of coming to harvest early in the season. Actually wheat begins to reach the wharves of Geraldton before the end of October. On the other hand, the grain is of high quality, and where the soils are suitable, good crops are grown in favourable seasons. Rotations are, naturally, limited in such a region, attention being focused on the cash crop.

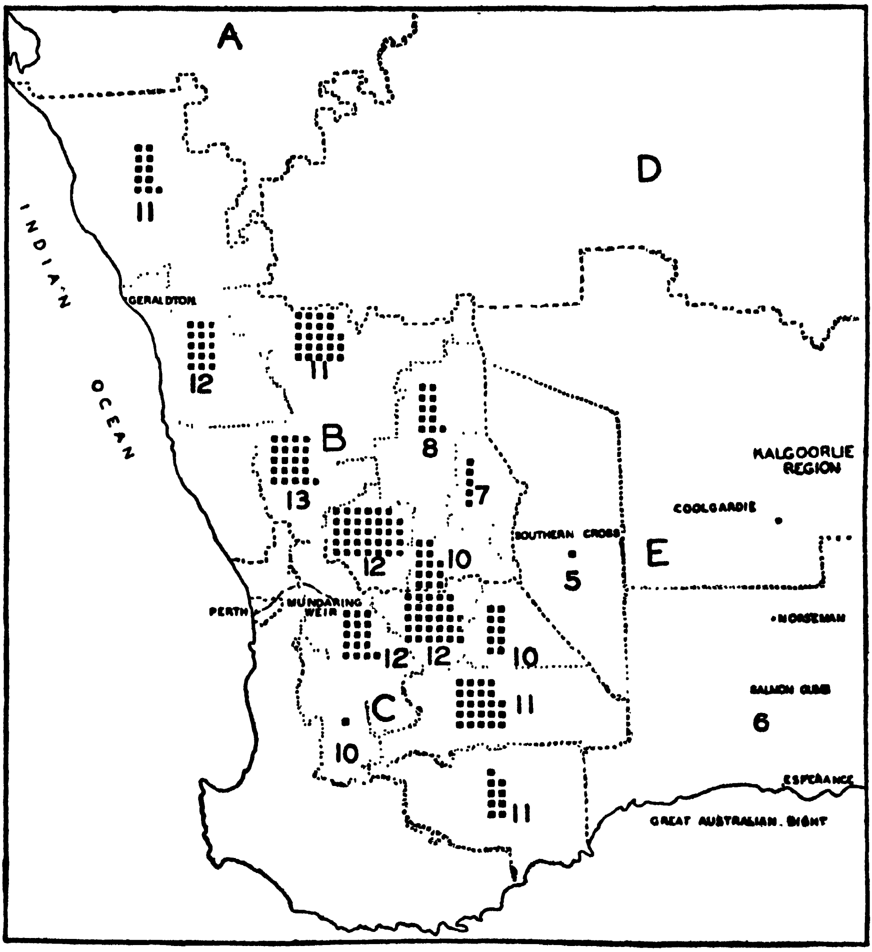


Fig. 45. The Wheat Belt in Western Australia

One square equals 100,000 bushels of wheat
Figures indicate yield per acre
Average 1940/41–1944/45

The position of the groups of squares within each region of the map is not geographically significant in Figs. 45, 48, 51 and 53.

A = North-Western Division
B = Northern Agricultural Division
C = South-Western Division
D = Northern Goldfields Division
E = Eastern Goldfields Division

Broken lines indicate boundaries between the divisions. Dotted lines indicate boundaries between the areas to which the squares and figures refer.

(*S.M.W.*)

Plate 26. Artesian bore and windmill-pump, Glenroy, N.S.W.

(*S.A. Land Development Executive*)

Plate 27. Scrub with stunted stringy bark and yacca, Kangaroo Island, S.A.

(S.M W.)

Plate 28. Curly Mitchell grass, Gilruth Plains, southern Queensland

(*Aust. National Publicity Assn.*)

Plate 29. Merinos in sheep yards, Deniliquin, N.S.W.

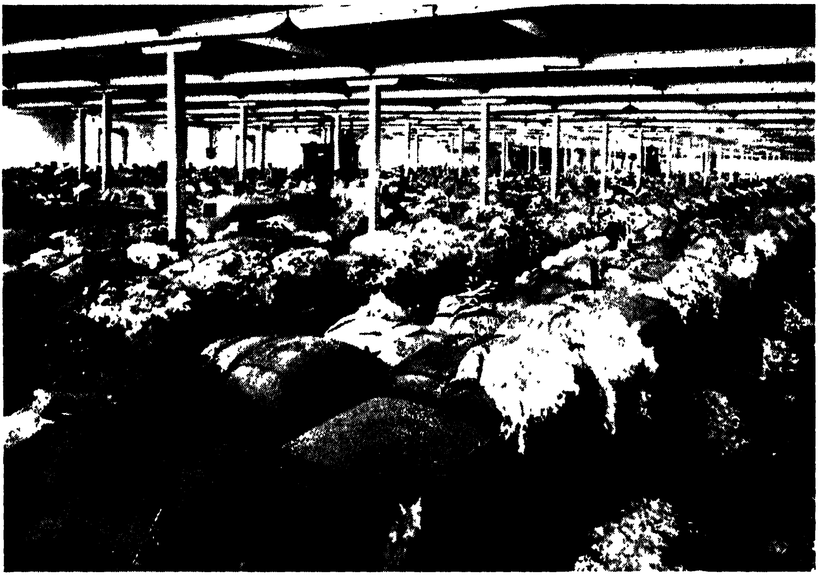
(C'wealth Dept. of Information)

Plate 30. 2500 sheep on stock route, W.A.

(Aust. National Publicity Assn.)

Plate 31. Sheep shearing

One side of shearing 'board'. Shearing is usually done by power-driven equipment.



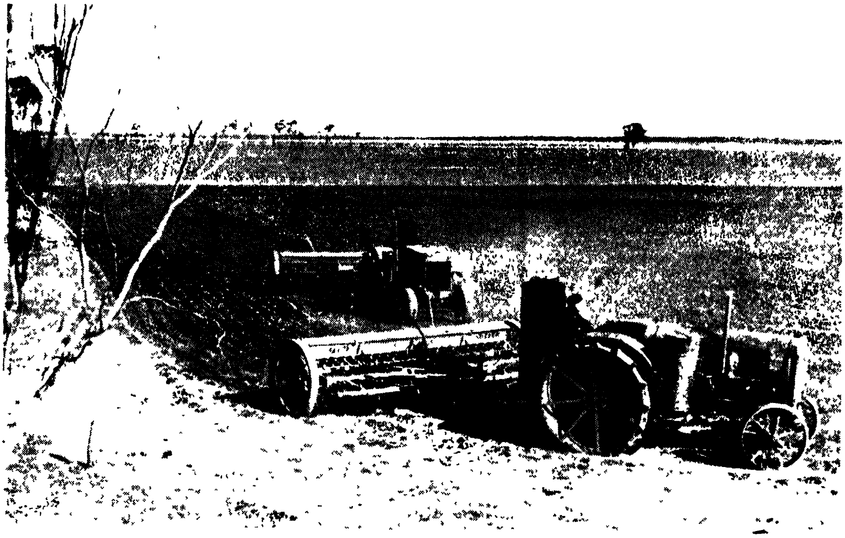
(*Strachan & Co Ltd.*)

Plate 36. Wool display before auction, Geelong, Vic.

Wool bales, showing catalogue numbers, ready for inspection.

(*C'wealth Dept. of Information*)

Plate 37. Bidding at a wool auction, Sydney



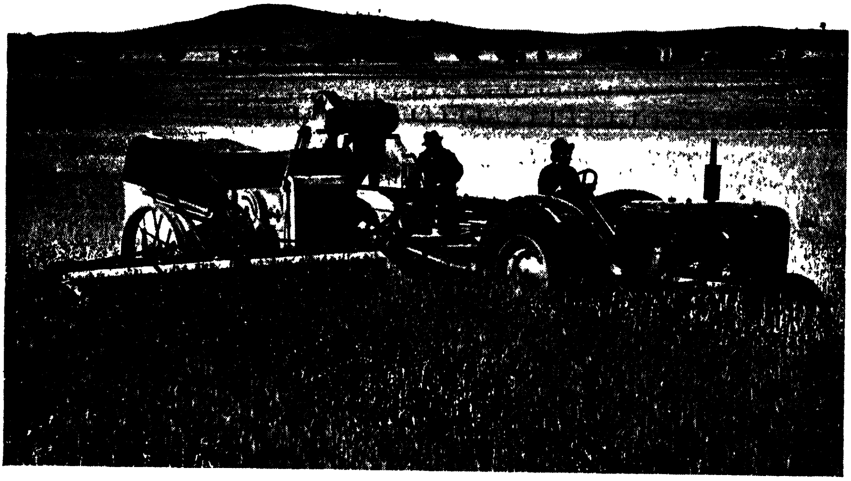
(C'wealth Dept. of Information)

Plate 38. Wheat cultivation on 'sand plain', W.A.

Some tractors are equipped with gas-producer units in this state, farmers often producing their own charcoal. Gas-producers were widely used during World War II.

(Aust. National Publicity Assn.)

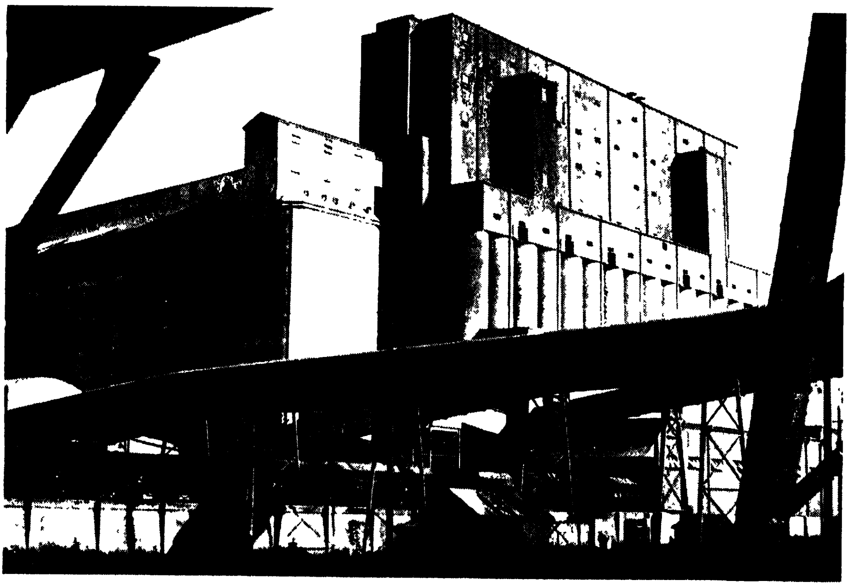
Plate 39. Sowing a wheat crop in S.A.



(*H. V. McKay Massey Harris Pty. Ltd.*)

Plate 40. Header harvester at work, Dookie, Vic.

This machine (*cf.* Plates 16-17) cuts the ears off with a mower type knife and threshes and winnows at the same time.



(*Aust. National Publicity Assn.*)

Plate 41. Wheat silos, Darling Harbour, Sydney

This silo has a capacity of 7,500,000 bushels. Most of the wheat is transported in bulk and stored in silos before shipment.

Passing southwards, the spread of the rainfall through the year increases slightly, but the critical factor deciding the success or failure of the crop in a year is still the time at which the last 'effective' rains fall. In an exceptional season, when rain falls particularly late, rust is sometimes a serious menace. The difficulties in respect to water supply vary considerably with the locality, but are typical of many areas in the northern half of the Western Australian wheat belt. In some regions artificial water supply schemes have been installed. The most notable of these are those connected as subsidiaries with the Main Pipe Water Supply, which runs from Mundaring Weir (with a storage capacity of 16,754 acre feet) to the Kalgoorlie goldfield (Fig. 71).[1] Others have been developed by using as catchment areas some of the rounded granite bosses which, in certain places, project through the surface soils; during rainstorms the water runs off the solid granite, and is diverted by concrete walls into small reservoirs, from which it is reticulated in pipes to the farms (Plate 71). On the other farms the supply, even for the simplest domestic needs, is very unsatisfactory. After the drought of 1911, over 1,500 bores were sunk; of these only 200 gave reasonably fresh water, 130 stock water, and 1,186 gave either no water at all or supplies which were too salty even for stock. Recently a comprehensive scheme, involving a piped supply to every farm, has been drawn up, but its capital cost, which was estimated in 1943 at £10,000,000,[2] would involve annual sums to cover interest and amortization which would be beyond the economic capacity of the farms. Fig. 46 shows the effect of the droughty season 1936-37 on the wheat areas in this state, and emphasizes the relative reliability of the southern section of the wheat belt.

In the southern third of the belt, although the rainfall is rather more distributed, the water problem is often acute. Dam catchments are poor; saline ground water is common and often restricts the depths to which dams may be sunk. Many of the better-developed farms have considerable numbers of sheep, while the rather greater reliability of the rainfall has led to a greater stabilization of the farming system.

In some areas the soils have developed salt troubles, which have occasionally led to disaster. In 1928, the Western Australian government put forward a scheme for the settlement of 3,500 farms in areas adjacent to the present south-eastern boundary of the wheat belt. Fortunately, a soil reconnaissance was made before the scheme was actually launched, and as a result of that survey the project was dropped.[3]

1. The water is pumped through the Mundaring-Kalgoorlie steel main, mostly of 30-inch diameter, by a series of eight pumping stations, involving a total net lift of 1,280 feet. Under present conditions it takes about two weeks for the water to reach Kalgoorlie. The prices charged for domestic supplies range from 2s. to 6s. 8d. per thousand gallons.

2. This scheme has been approved by the Commonwealth for sections to cost approximately £4,000,000 (1947).

3. MS., Prescott, J. A., *Notes on a Visit to Western Australia,* 1930. See also Teakle, L. J. H., 'A Regional Classification of the Soils of Western Australia,' *Proc. Roy. Soc. W.A.*, Vol. xxiv, 1938.

On the eastern margins of the wheat belt there are areas of country which could be used for production; for instance, the crop has been grown at some localities as far inland as Southern Cross, on the main east-west railway line. However, the limited and unreliable nature of the rainfall and the low average yield which is to be expected over a period of years renders such development a hazardous enterprise, in which success ultimately depends

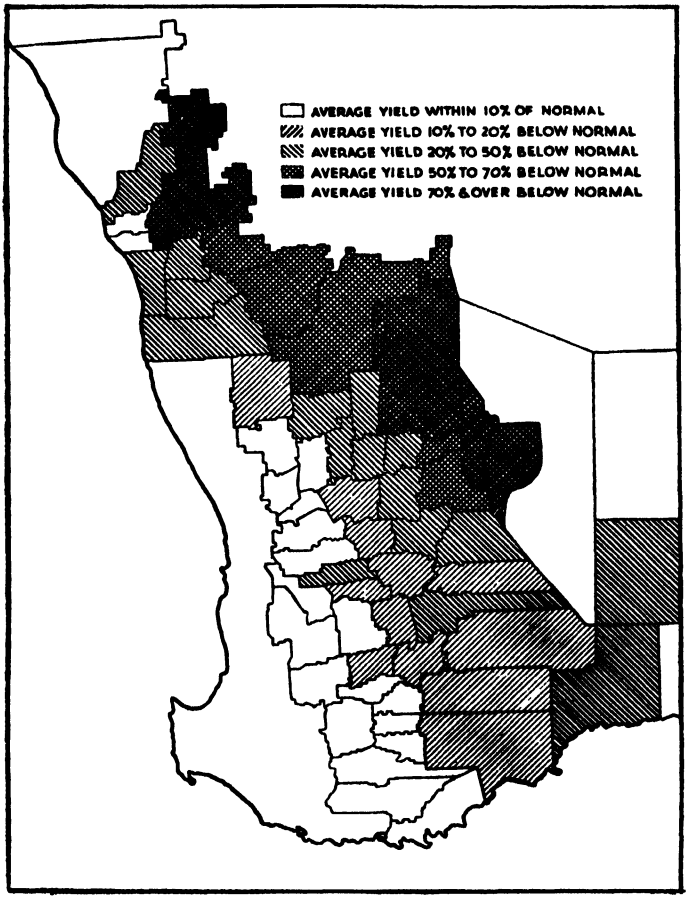


Fig. 46. Distribution of Drought Conditions in the Wheat Belt of Western Australia, Season 1936-37

on the price of the commodity. Experience suggests that, before world wheat prices had reached and been maintained at a sufficiently high level to warrant the opening of these areas, many other potential wheat-growing districts of the world would have been opened and developed. In this area, therefore, a scheme of regrouping farms on a grazing basis for wool production has been adopted.

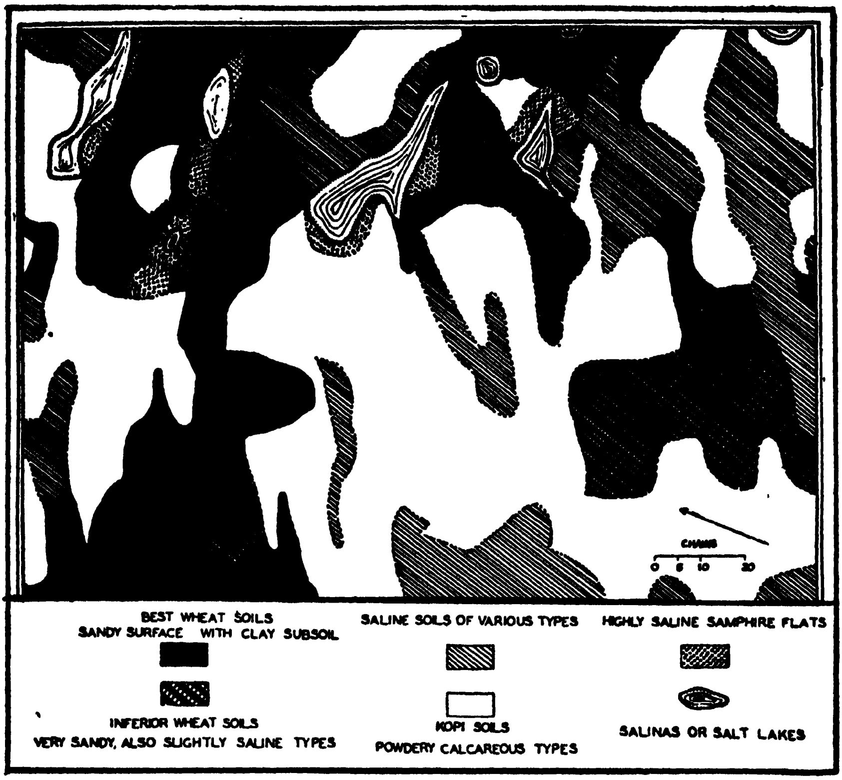


Fig. 47. Generalized Soil Map of an area of Sub-Marginal Wheat Country near Salmon Gums on the Coolgardie-Esperance line

In 1899 a branch railway was started from the main east-west line at Coolgardie, running southwards (Fig. 5). This line reached Norseman in 1919, and in 1929 was completed as far as the small port of Esperance. Attempts have been made to settle the land around the southern parts of this line as an agricultural area, but the rainfall is low, and decreases sharply away from the coast. Soil characteristics which militate against satisfactory wheat-growing include excessive salinity, which is serious over considerable areas, and a condition not clearly understood in the so-called kopi soils. Kopi soils are grey, highly calcareous, powdery types associated with morrel (*Eucalyptus longicornis*) woodland or types of Mallee scrub. Fig. 47 gives an example of the distribution of saline and kopi soils on which wheat-growing has consistently failed in this district, together with the more or less satisfactory wheat soils. Fortunately, Wimmera rye grass does quite well on many of the soils of the district which are unsuitable for wheat growing and is the basis for an expanding stock industry. The yields obtained were

insufficient to enable the settlement as a whole to be self-supporting on a wheat-farming basis. Many of the settlers have now left their farms, and there seems little doubt that the area is to be regarded as one in which grazing is the main line of activity, although on selected spots a lenient system of cropping may be practised as an accessory to wool production. Fig. 47 shows a soil map of an area of 2,190 acres in this district.

Broadly speaking, the wheat belt of Western Australia is still in the transitional stage. The universal need for superphosphate is well recognized, satisfactory wheat varieties have been produced, and the general standard of cultivation is improving, although a good deal of poor farming is still evident. Part of this is inevitable in an area of agriculturally young soils which still retain some of the variability of virgin land; part is due to the fact that the expansion of the industry was rapid in the period 1920-28, and many men with little or no farming experience or knowledge were attracted to wheat-growing either as a means of gaining a livelihood or as a method of acquiring wealth quickly. The land was cheap, and as long as a boom was developing it was possible to clear a farm and sell it at a profit after a few years. The economic depression and the poor seasons which accompanied it dispelled these hopes, and over a thousand farms were abandoned. The general need for a leguminous plant in the rotation is evident, particularly on the lighter soils. In some places where rainfall is not too low special varieties of lupins (mainly *Lupinus varius*) are proving their value; most of the wheat districts have too restricted a rainfall for subterranean clover.

South Australia West of the Murray (Fig. 48)

In South Australia, the Western Division contains a considerable area of wheat land in Eyre Peninsula, and along the eastern seaboard of the Great Australian Bight as far as the district around Fowler's Bay. In this division the average area under wheat increased from 226,000 acres in the period 1905-09 to 655,000 acres for 1925-29. The western section of this division is of particular interest because it is definitely a marginal area for wheat production, as was shown by an expert Agricultural Settlement Committee set up by the state government as early as 1930.[4] This committee prepared the map shown in Fig. 49, which indicates the mean wheat yield for the seventeen-year period, 1913-29, in each 'hundred'[5] of the state. The low yield which has been experienced in many of the settlements is partly attributable to the year to year variations of the rainfall, partly to the relatively poor nature of many of the soils, and partly to the fact that some of the area cropped is not fully cleared, and, therefore, cannot be regarded as entirely satisfactory for comparative purposes. During the period reviewed the state

4. *Report of the Agricultural Settlement Committee* (Govt. Printer, Adelaide, 1931).
5. The 'hundred' is the smallest statistical unit in South Australia and is usually about 100 square miles.

had found it necessary to afford drought relief assistance in seven separate years, and, although farmers had been able to repay that assistance in many cases prior to 1927, this ability was, naturally, influenced by the price obtained for the wheat during the period.

The system of agriculture is mainly dependent on wheat-growing, but some sheep are kept. Lack of an effective water supply is, in some instances,

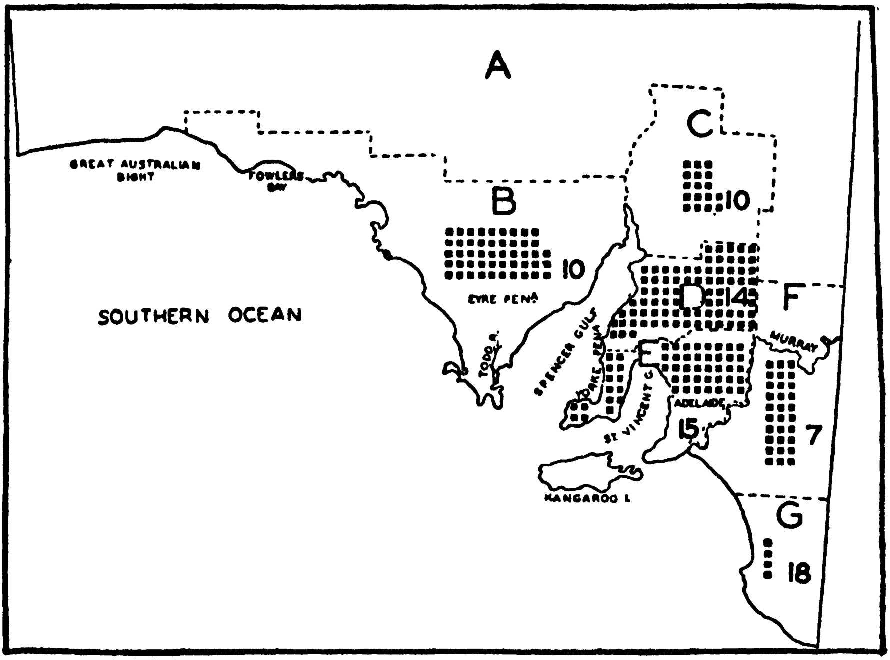


Fig. 48. The Wheat Belt in South Australia

One square equals 100,000 bushels of wheat
Figures indicate yield per acre
Average 1940/41–1944/45

A = Area outside the counties
B = Western Division (portion of which is subdivided into counties)
C = Upper North Division
D = Lower North Division
E = Central Division
F = Murray Mallee Division
G = South-Eastern Division

an obstacle to the maintenance of stock; but the completion of the Todd River Reservoir in 1924 (with a storage capacity of 9,258 acre feet), and the reticulation of its water to many farms in Eyre Peninsula, made a great change in this respect.

As is common in most Mallee areas, the soils are variable, and not especially fertile. The use of phosphatic manures is essential for efficient agriculture, but the actual quantities used are frequently inadequate for good results. The Agricultural Settlement Committee in 1931 reported that:

The results of departmental and other experiments show that an application of 2 cwt. of superphosphate per acre not only gives the best financial returns from the point of view of the wheat crop, but that such returns enhance the grazing value of the herbage when the land is allowed to be in pasture. When, however, one turns to the Statistical Register to see how far these results are applied in practice, it is found that, for the State as a whole, only 82 lb. of superphosphate is applied, and that in no single district of the State does the average amount exceed 1 cwt. per acre. Indeed, in the Western Division the average amount of fertilizer used is only 65 lb. per acre. The relatively small amount of fertilizer used in this Division is somewhat surprising, in view of the need of Eyre's Peninsula soils for soluble phosphates, and of the fact that departmental experiments at a number of centres in this district have demonstrated that 2 cwt. per acre is the most profitable dressing.

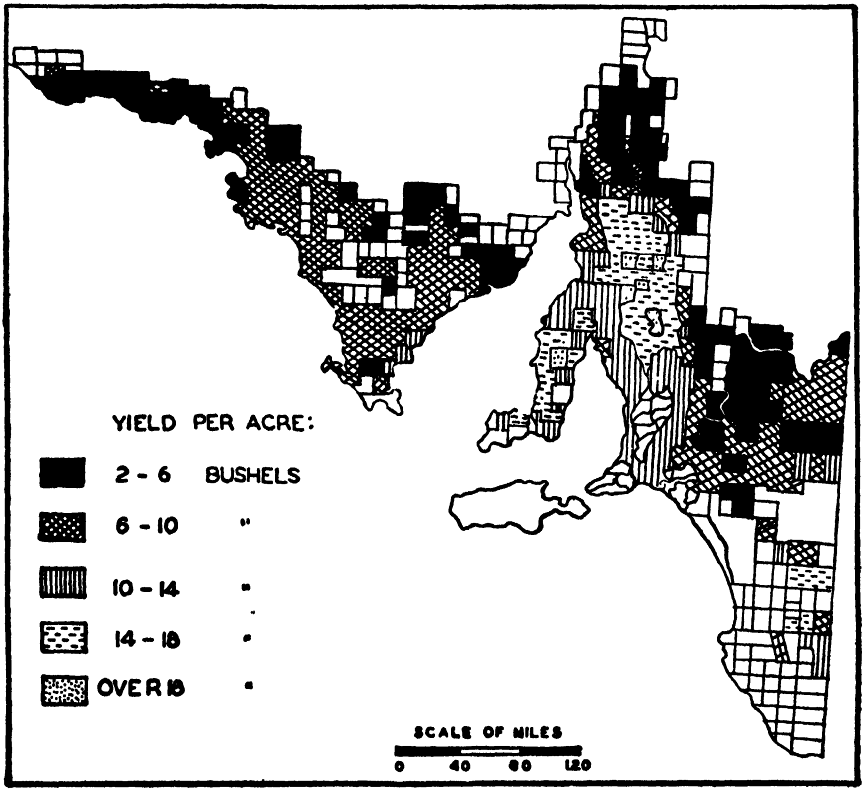


Fig. 49. Mean Wheat Yield during a period of seventeen years (1913-29) in the 'Hundreds' of South Australia

On the eastern side of Spencer Gulf are the Upper and Lower North and the Central Divisions, the three sections of the state which were responsible for its development as a wheat-producing country. In the first of these, average annual rainfall is little over ten inches; variability is

nowhere below 25 per cent (Fig. 43). The soils are variable, but seldom remarkable for their fertility, so that only in the southern sections of this Division does the average yield exceed ten bushels per acre (Plate 39). Much of the wheat-growing in the outlying parts is speculative in nature, the farmers contenting themselves with drilling in the crops on imperfectly prepared land, in the hope that, if the season should prove satisfactory, they may obtain a moderate yield; knowing that, in the event of failure, their stake in the gamble has been relatively light. The Lower North and Central Divisions contain many areas of first-class land, while some of the farmers, particularly those on Yorke Peninsula, have the additional advantage of being

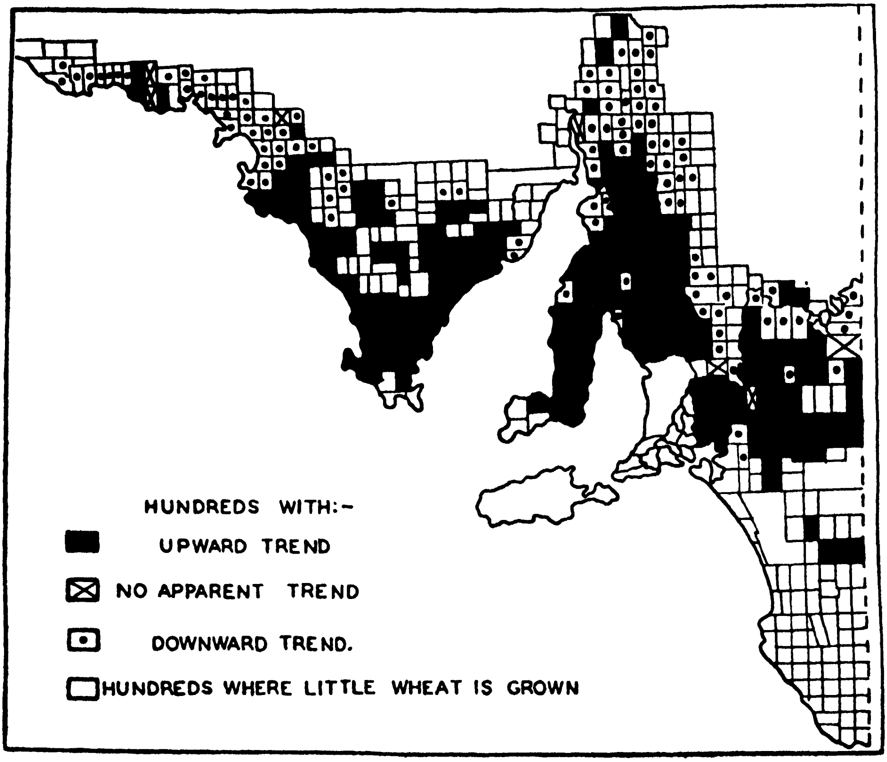


Fig. 50. Trends of Wheat Yields during the period 1913-37 in the 'Hundreds' of South Australia

able to produce high-grade malting barley, which gives them an alternative cash crop, the price of which is governed by the export market.[6]

6. During the ten years 1930/31 to 1939/40 the overseas exports of barley, largely for malting, from South Australia averaged 145,000 centals per annum, of which the majority comes from these districts, which, in addition, supply a certain amount of this grain to other states in the Commonwealth.

The years of unsatisfactory crops are either those in which a heavy fall of rain late in the summer preceding sowing washes the stored nitrate from the soil, or those in which the spring rains fail, and the crops are unable to make satisfactory growth during the later stages of their development. The older practice of the wheat farmers in these districts was to grow wheat after a period of fallow of rather less than one year's duration, during which the weeds were controlled and nitrogenous plant foods accumulated in the soil. A certain number of sheep were kept on the farm for the production of wool and fat lambs; the grazing available under this system was mainly on the stubbles and fallows, though in some places a certain amount of land was used specifically for providing them with grazing material. More recently progressive farmers have been discovering that with a longer period of rest between cereal crops and the increased growth of leguminous plants such as peas, lucerne or 'barrell medick' (*M. tribuloides*), in the lengthened rotation, it is possible to obtain much higher yields per acre, which with the increased returns from livestock make up for the smaller area cropped.

The success of this recent development is actually based upon procedures which tend to raise the fertility of the soils concerned and is a practical demonstration of the unsoundness of the older system of wheat-growing. The actual extent to which soils which are not so treated are being 'mined' is difficult to determine, because changes in fertilizing, in the varieties used and the variability of the rainfall make the direct use of yield statistics troublesome.

One particular investigation has been made in this matter. In it the yields of wheat in each 'hundred' of the state were examined for the quarter-century ending in 1937.[7] Corrections were applied for the climatic factor and then the trend of yields during the period was worked out for each of these small statistical units. The result is shown in Fig. 50, from which it can be readily seen that in most of the 'hundreds' of better rainfall the yield-trend of wheat is upwards, while in the drier and more speculative regions for which no satisfactory system of rotation has been developed the yield trend is downward.

The Murray-Mallee Division of South Australia and Mallee District of Victoria (Fig. 51)

This region can be treated as a whole, although in general the rainfall of the Murray-Mallee is more reliable. The whole Mallee region consists of an area of sandy soil, originally covered with a scrub vegetation. Most of this country has been cleared during the last half-century for the purpose of developing wheat farms, but there are several belts, totalling about 4,294,000 acres, which have never been made available for settlement, owing to their refractory nature. A proposal by the Victorian government in 1927 to

7. Cornish, E. A., Phipps, Dr. I. F., and Pugsley, A. T., in a forthcoming paper.

develop 590,000 acres of this area for the settlement of British migrants was rejected by the Development and Migration Commission, which was a body set up by the Federal government to investigate development schemes requiring loan expenditure subsidized by the British government.

In regions of this type the question of water supply is one of considerable difficulty. In the early days, when surface water was relied upon, it became

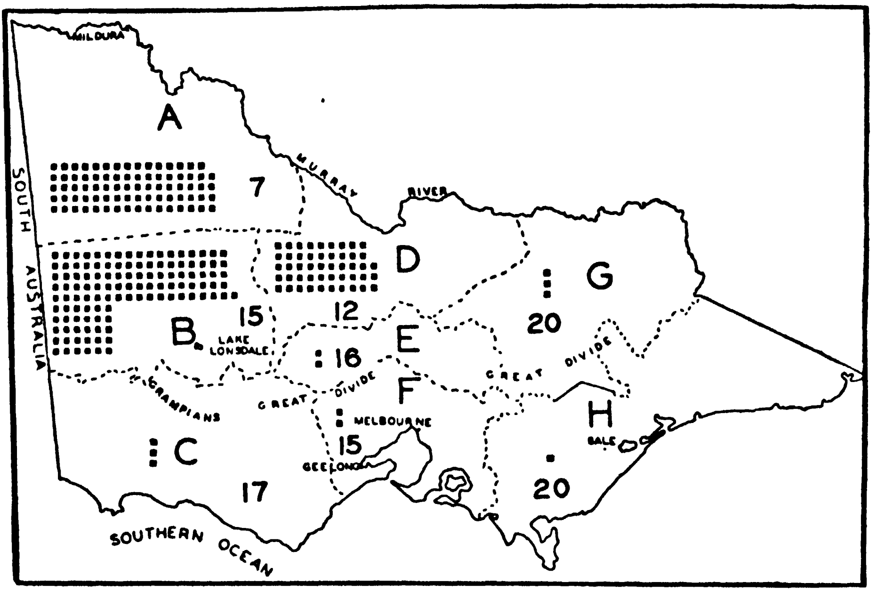


Fig. 51. Wheat Belt in Victoria

One square equals 100,000 bushels of wheat
Figures indicate yield per acre
Average 1940/41–1944/45

A = Mallee
B = Wimmera
C = Western District
D = Northern District
E = North Central District
F = Central District
G = North-Eastern District
H = Gippsland

necessary to evacuate whole areas in seasons of heavy drought. A comprehensive boring scheme was inaugurated, and it was found that potable waters suitable for stock were to be obtained by development of sub-artesian bores in the western half of the area, whereas in that part lying east of a meridian passing through Mildura such water was too brackish to be of value. Accordingly, the Victorian government developed a scheme of stock and domestic supply to serve many of its districts. Under this system water is conserved in reservoirs at Lake Lonsdale and in the Grampian Ranges to the south, and pumping stations have been installed upon the Murray. More recently the Goulburn system has been linked to the eastern side of this reticulation, while

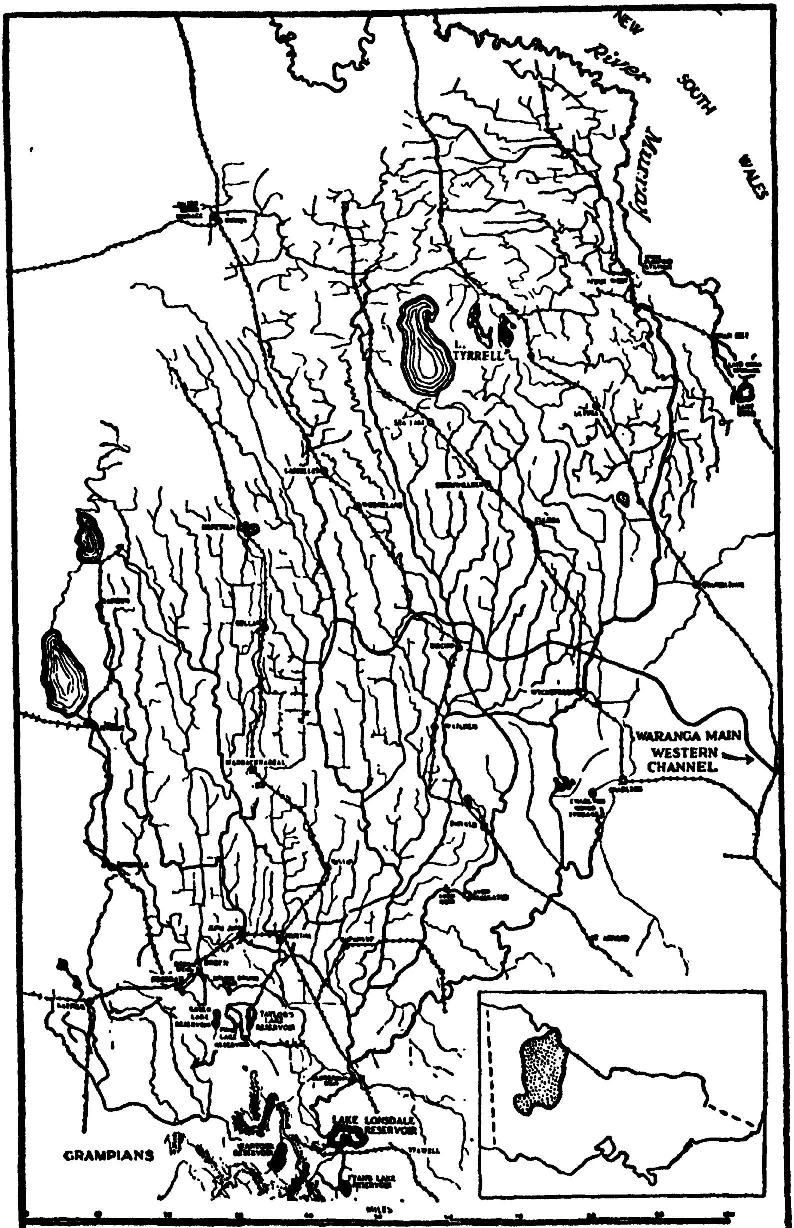


Fig. 52. The Gravitational Water Supply Scheme for Stock and Domestic Purposes in the Victorian Mallee and Wimmera

This is reproduced from a map of the network of channels prepared by the Victorian State Rivers and Water Supply Commission. It also shows the storages fed from the Grampians, the main supply channel from the Waranga Reservoir in the Goulburn Valley, the principal towns in the area, and the railway communications.

works are in progress whereby the waters of the Glenelg will be brought round the western side of the Grampians from the Rocklands Reservoir. Water is supplied to the farms once a year by an open channel system, which is operated during the winter months when the rainfall has moistened the soil. Some of the channels are over 200 miles long, while their total length is about 8,000 miles. (Fig. 52.) The excavation of suitable earth tanks on the individual farm is the task of the farmer himself. This development of reliable supplies of water has given the agriculture of these districts a stability which they would otherwise never have possessed. In recent years a movement has been started to demand that the water shall be piped, thus using it with much greater effect. Such a proposal is quite uneconomic but may be adopted in years to come. The annual rainfall increases towards the southern edge of the area, but in the northern sections of the Victorian Mallee it is both low (10 to 12 inches) and variable. The wheat yields harvested in these districts during the last ten years are shown in the table on pp. 166-7.

These figures give some idea of the uncertainty of wheat-growing in the Mallee areas in South Australia and Victoria. In the former the two northern counties, Young and Hamley, show five and six years respectively in which the average yield was less than two bushels per acre.

The averages are a singularly poor advertisement for the districts, but a proportion of the newly-settled farmers either did not understand or did not practise methods which are necessary for successful wheat culture. Even if the best methods known are employed, and the areas of poorer soil are left uncultivated, it seems as if an average annual yield of ten bushels per acre is the best which can be expected in the drier sections, while eighteen bushels would be a high average in the parts with better rainfall. It is possible that if a leguminous plant could be found which could grow readily in the drier counties, and if it were introduced as a stage in a long rotation, better results might ensue; but the variability of the rain makes any stabilized farming system difficult. Meanwhile, wind erosion is menacing and radical changes in the methods of land use are now seen to be necessary.

The only alternative form of husbandry which farmers in these districts can undertake at present is that of sheep-raising. The availability of the water supply has led to a steady increase in the flocks. Some account of the feed available has already been given in chapter v. The scarce and unreliable summer rainfall and the low humidity make summer cropping too risky to be generally undertaken. Of other winter crops, oats grown for grazing purposes, and feed barley are the best alternatives. Both of these are cereals, and, therefore, not wholly desirable as alternatives to wheat in a rotation of crops. Moreover, any attempt to grow barley on a large scale would swamp the local market, and the ensuing reduction of price to 'world parity less overseas freight' would make the crop generally unprofitable.

Wheat Yields by Counties in South Australian and Victorian Mallee Areas, Over a Ten-Year Period

(Bus. per Acre)

Murray-Mallee Division of South Australia

County	1935/36	1936/37	1937/38	1938/39	1939/40
Albert	4·72	6·66	10·19	4·84	4·71
Alfred	4·33	9·59	11·53	5·03	6·20
Buccleugh ..	8·40	7·45	9·84	5·86	6·46
Chandos ..	10·59	11·88	15·47	8·75	7·20
Hamley ..	0·10	5·51	6·72	0·95	1·89
Russell	7·52	7·28	7·58	5·77	7·03
Young	0·80	6·58	7·61	1·89	2·67
Average ..	6·53	8·80	11·48	5·86	6·03

Murray-Mallee Division of South Australia (Continued)

County	1940/41	1941/42	1942/43	1943/44	1944/45
Albert	2·46	8·89	11·37	1·60	1·31
Alfred	3·27	11·78	13·11	1·83	1·66
Buccleugh ..	6·75	8·21	9·58	9·52	4·51
Chandos ..	7·52	15·00	13·69	12·25	5·21
Hamley ..	1·81	5·74	7·09	0·14	0·02
Russell	4·91	6·93	9·12	7·04	2·13
Young	1·95	7·06	9·91	0·55	0·18
Average ..	6·97	10·99	12·22	5·89	2·69

Source: *South Australian Statistical Registers.*

Mallee District of Victoria

County	1935/36	1936/37	1937/38	1938/39	1939/40
Millewa ..	3·23	7·20	9·67	0·95	9·20
Weeah	10·03	11·08	12·75	6·87	7·71
Karkarooc ..	9·65	13·26	13·97	3·89	12·93
Tatchera ..	12·39	15·44	11·32	2·46	17·03
Average ..	9·72	12·98	12·69	3·62	13·29

Mallee District of Victoria (Continued)

County	1940/41	1941/42	1942/43	1943/44	1944/45
Millewa ..	0·42	9·28	11·16	0·01	0·04
Weeah	5·31	13·80	13·96	7·84	2·53
Karkarooc ..	2·73	12·90	15·42	7·13	1·14
Tatchera ..	1·61	8·42	15·19	4·42	·14
Average .	2·54	11·32	14·89	6·13	0·91

Source: *Victorian Year Books.*

The soils are variable; in some places they consist of fertile loams, while at the other end of the scale are regions which are lacking in nutrients and the vegetation is of a desert character, and hills of white sand are the dominant feature of the landscape. Saltpans occur locally, and instances of infertility due to an accumulation of salt in the soil have been recorded.

From this description it will be seen that these districts are not inherently rich; and, consequently, they are unsuited to small-scale farming except where irrigation becomes practicable and types of produce are grown which are capable of meeting the cost of the water and of the necessary manures. For general wheat and sheep farming, the use of the land is bound to be prodigal in acreage if the farming is to be carried out on an economic basis. It costs about £2 to £4 per acre to bring the farm to a productive state, and a further £1,000 to £1,500 to equip it with machinery and tractive power for cropping. If the area under crop is insufficient to support this capitalization, costs per bushel are likely to be high.

In the more productive districts the minimum economic size of a farm is about a square mile, while on the poorer soils, and where the rainfall is less satisfactory, 1,280 or more acres are required. Half a century ago, when settlement of these areas was beginning in Victoria, 320 acres was frequently the area allotted to individual farmers. This was later increased to 640 acres, and, of course, many of the earlier holdings have been increased by aggregation. After World War I settlement was on a 640 to 1,000-acre basis; but, in the re-settlement schemes which have been undertaken since the economic depression of 1930 these figures have been largely increased, and many of the settlers on light lands in the northern section have been allotted 2,500 acres, with the expectation that the farms will be used for grazing and some wheat-growing, rather than for wheat-growing with some grazing. Incidentally, much of the capital sunk in developing the original farms and in meeting losses during depression years is to be written off; in other words, is to be transferred from the settlers to the state. In 1935, average working costs of growing wheat in these areas (apart from interest on capital), varied

from about 2s. 6d. to 4s. per bushel in the average season;[8] doubtless they have risen considerably in the last few years.

The Main Wheat Belt of South-Eastern Australia—Winter Rainfall Zone (Figs. 51, 53)

The broad sweep of land between the dry areas of the Mallee and the ranges which follow the arc of the coast in Victoria and New South Wales contains many types of country. The terrain is mostly flat, and forms part of the drainage basin of the Murray and its tributaries. In the Victorian sector the rainfall is mainly of the winter type, and has an annual average of from 16 to 20 inches (Fig. 43). In New South Wales the southern sector is similar, but towards the north summer precipitation increases, while the winter rain decreases. The soils offer a range of types, the best being generally used for wheat-growing.

Wimmera. This division of Victoria has five main soil types: (i) Mallee soils in its northern boundary; (ii) large areas of light sands suitable for grazing only; (iii) rocky types on the northern foothills of the Grampians; and finally those parts of the plain country which are used for wheat-growing, and are of two types—(iv) a red-brown earth, and (v) a grey chernozem-like soil. These last two soils, locally known as 'red' and 'black', are frequently interwoven in the same paddock, or one of them may predominate over large areas. The grey soil is of special interest; although at first it was regarded as somewhat intractable country, and definitely inferior to the red land, it now provides one of the most fertile regions of Australia. It consists of a deep, self-mulching clay-loam, high in lime; it cracks deeply in dry weather, and is very sticky when wet. Originally the surface was uneven owing to innumerable small depressions. Cultivation has gradually brought the paddocks into good order; but, more important still, the farmers have discovered the special technique necessary to achieve efficiency. Fallowing is essential if high yields are to be obtained, and cultivation must be clean or weeds grow luxuriantly. It was found that, if the soils were ploughed when wet, with a special plough bearing a skeleton mould-board, the resulting surface could be worked down to an effective mulch as the land dried in the spring. Later, as paddocks have become level, a broad-share cultivator has taken the place of the plough on many farms. It was also found that late sowing was usually more effective than early sowing, partly because it made better control of weeds possible, and partly because crops sown in March become too rank and in wet years could not be eaten down by sheep. Special varieties of wheat have also improved the yields. During the last ten years it has been discovered that a small addition of a zinc salt led to a significant increase in wheat yields.

8. See *Second Report of Royal Commission on Wheat, Flour and Bread Industries*, 1934-35, p. 58 *et seq.* (Govt. Printer, Canberra).

All these methods had to be worked out before the modern system was evolved; without their development it would have been impossible for this type of country to have achieved its reputation for fertility, based, as it is, on the expectation of average yields of over twenty-five bushels per acre, while more than forty bushels may be produced in good seasons. In 1935 the working costs of producing wheat in the Wimmera were of the order of 2s. per bushel,[9] which means that they compared favourably with those of any other region in the world. The large number of modifications introduced into farm practice before the agricultural system reached efficiency is typical of the general trend in agricultural development in any new district. These soils happen to be extremely fertile, and the result has been very striking. On less fertile areas the same type of development is to be expected, although the final result is not likely to be so satisfactory.

The red soils of the Wimmera tend to set hard when dry, and are more difficult to cultivate. They require different treatment, and seldom give yields which are as high as those obtained on the grey; consequently, they are a handicap when the two kinds are interspersed. Both kinds give satisfactory grazing for sheep when superphosphate has been applied. On the grey soils, the farmers with small areas are unable to keep a permanent flock, because the whole of the farm is under wheat or fallow. However, they are often able to let their stubbles for grazing, or to 'buy in' sheep for a few months. At present the rotation system of wheat-fallow-wheat is apparently causing no diminution of wheat yield through depletion of soil nutrients. On the other hand, no increase in wheat yield has occurred despite the introduction of improved varieties, and, further, yields of oaten hay have shown a decline.[10] At present there is no conclusive evidence of physical deterioration leading to erosion. To the European eye, the lack of a leguminous crop, and the absence of nitrogenous fertilization, is striking; the reasons for this state of affairs are probably to be found first in the rate of nitrification, which seems to be particularly high in this well aerated, alkaline soil during a large part of the year, and, secondly, in the volunteer growth of medicks.

On such an area of fertile land the weed problem might be expected to become acute. However, the long, relatively dry summer makes it difficult for any weeds to grow except those which have the same growing period as the wheat, and the system of spring and summer cultivation under which the fallows are worked shortly after each fall of rain effectively checks these types. Unfortunately, some seed of Hoary Cress (*Lepidium draba*) entered the district about twenty years ago, and the weed has made considerable

9. See *Second Report of Royal Commission on the Wheat, Flour and Bread Industries*, 1934-35, pp. 58, 82 (Govt. Printer, Canberra). This figure is based on the price at the local railway siding, and includes a charge to cover the farmers' own labour, but excludes all interest charges. Profits from side-lines are credited to wheat.

10. Forster, H. C., 'Fertility trends of Victorian soils as affected by certain rotational systems,' *Jour. of Agric., Vic.*, Vol. xxxvii, 1939, p. 130.

progress, though, fortunately, its rate of spread is slow. The deep rhizomes of this plant, and its capacity to withstand summer dryness, make it well fitted for the district, and some farmers have had to take drastic steps to eradicate it with chemicals.

Manifestly, cheap methods of surface cultivation are an essential for this type of land, and for that reason large implements, drawn by modern fast-moving tractors, have an advantage if they are efficiently managed. This means that small farms are at a disadvantage when compared with large. The value of the land increases the tendency to discard the horse as a source of power. On the other hand, the tractor farmers found it difficult during the depression to meet the costs of machines and fuel when the price of wheat was of the order of 2s. per bushel at the local siding. The logical outcome of these factors is the tendency for farmers to acquire large holdings; and, consequently, when wheat prices are high, land values rise. In 1928, before the depression, over £30 per acre was at times paid for limited areas. The Royal Commission on the Wheat Industry found an average interest charge of 10¾d. per bushel in this district. Naturally, many men were in difficulties at that time, but the number of dispossessions was relatively small.

The *Northern District of Victoria* is interesting, because it is an area in which wheat-growing has declined during the last forty years. This is partly because irrigation areas have been developed, and much of the land has been diverted towards other production. Apart from this, however, there is a widespread opinion among farmers of many years' standing that the structure of the soil has deteriorated through cropping methods. The loams and silt-loams of this district are physically poor, being easily beaten to a structureless mass by rain. After years of cropping even the slight natural structure is lost. A lenient system of cropping, with some diversification in forms of production, seems to be the essential feature of future development. In parts of these areas a type of 'plain' country, with heavy clay subsoils near the surface, is particularly difficult from the agricultural point of view.

Discussion of these districts leads on naturally to a consideration of the *North-Eastern Division of Victoria* and of the *'South-Western Slopes' and Riverina, in New South Wales.* (Fig. 53.) Here, again, the variety of soils is very considerable. Large tracts of the Western Riverina are definitely sheep country, as are those slopes of the foothills and ranges where soils are shallow. In the cultivable parts of the eastern section, where the rainfall is about twenty inches, a mixed wheat and sheep husbandry is developing, and attention is being given to pasture improvement. It seems certain that this practice will spread, but at present many farmers are content with a wheat-fallow or a wheat-fallow-'grass' (i.e., weeds) rotation, which is only partially successful unless legumes, such as subterranean clover, are introduced, thus developing a definite ley farming system. How far these soils are likely to stand the strain of such treatment is a matter of conjecture. Superphosphate

is the only manure used. To some extent, the farmer with a small area is at a disadvantage, since, in order to use his machinery and power unit effectively, he is impelled to adopt a narrow rotation, in which his cash crop recurs with a frequency dangerous to the soil. On the other hand, farmers with larger areas are, in some cases, liable to neglect cropping and rely too much on their

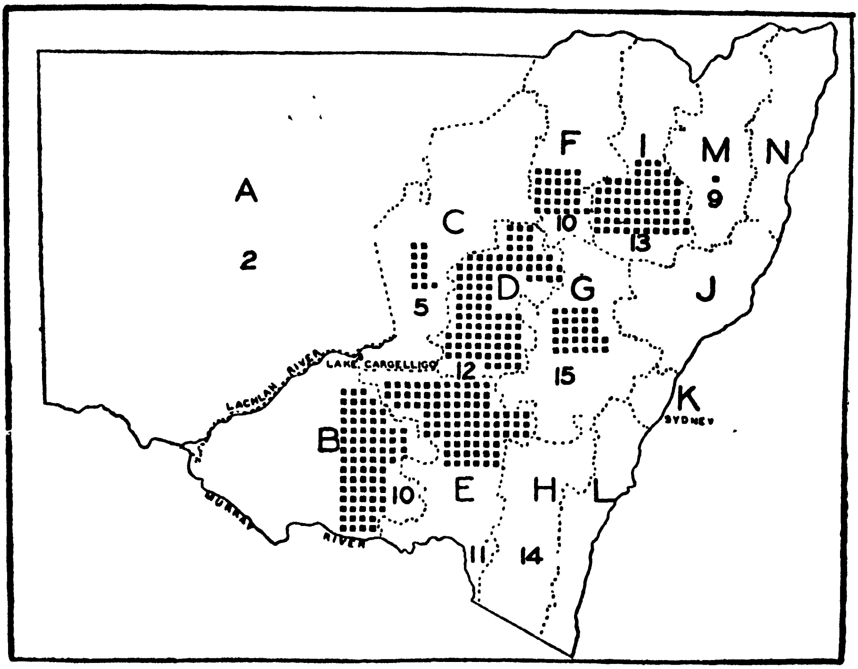


Fig. 53. Wheat Belt in New South Wales

One square equals 100,000 bushels of wheat
Figures represent yield per acre
Average 1940/41–1944/45

A = Western Division	H = Southern Tableland
B = Riverina	I = North-Western Slope
C = Central Plain	J = Hunter and Manning
D = Central Western Slope	K = Metropolitan
E = South-Western Slope	L = South Coast
F = North Central Plain	M = Northern Tableland
G = Central Tableland	N = North Coast

sheep. Although this reduces the worry and risk which the farmer would normally incur by managing his land with a greater agricultural bias, it also means that the land is not being farmed with the maximum efficiency.

The extreme case occurs on some properties maintained solely as sheep stations, and yet located on reasonably good soils in wheat areas. The owners of these properties have shown little inclination to engage in agriculture. A prolonged fall in the price of wool, accompanied by a steady market for

wheat, would probably have desirable results. It is impossible to estimate the extent of country to which this criticism applies, because the districts contain many areas of soil which are not first-class cropping land, and some in which cropping would be inadvisable or impracticable. Until a broad soil survey has been completed, no statistical information is worth while. It seems probable that the acreage concerned is of the order of tens of thousands rather than millions.

The weed problem has recently taken a new turn with the appearance of skeleton weed (*Chondrilla juncea*), which has spread rapidly in New South Wales, and is extremely difficult to control. This pest, which has a deep root system, an efficient method of seed dispersal, and is relatively unattractive to grazing animals, is making some amendment to farming practice imperative.

The Wheat Areas in the Summer Rainfall Zone (Fig. 53)

The Central Western Slope and Central Plain of New South Wales bring the survey to an area where the summer and winter rainfalls are approximately equal. (Fig. 43.) Four new factors here enter into agriculture: harvesting is more likely to be interrupted by rain, weed growth becomes more troublesome in the summer, and the prevalence of heavy summer rain makes gully or sheet erosion a menace on all sloping land. These factors are still more evident in the *North-Western Slope Division*, where wheat-growing presents a very different picture from that seen in Victoria.

At this north-eastern end of the wheat belt, with its marked summer rainfall, the most frequent cause of failure is a lack of rain during the winter. The crops are sown in autumn (March-June); they develop on the rainfall and nutrients accumulated in the soil during the preceding summer. Growth is rapid if the cultivations during the summer have been effective in preventing weeds from using the soil moisture. Early-sown crops may become too rank, and require grazing by sheep in July; late-sown crops do not usually need this treatment. Some rain is essential during winter and early spring if the crop is to reach maturity. On the other hand, unless the variety grown is resistant, a wet spring usually leads to the development of rust. Harvest occurs in October or November. Wheat has been grown in these regions for many years, but hitherto success has been only partial. This has been due to failure to appreciate the essential factors of success, the chief of which is certainly weed control during the summer. If heavy rains fall, they may do much damage by erosion, and in any case weed growth is so rapid that some farmers consider it imperative to harrow the whole of the area under preparation for wheat within a week after rain. This involves large-scale implements and tractors; in plain country, one power unit will deal with seventy to a hundred acres a day. Small-scale farmers, with relatively slow

horse teams, requiring time for harnessing and watering, are incapable of doing half the work in the time. It seems likely, therefore, that wheat production in these northern districts will develop along the lines of large-scale farming.

In *Queensland*, where the same factors apply, there are many farms with small areas under wheat, but on these the crop has a dual purpose; when feed is scarce, it is grazed off or turned into hay for dairy stock. Fallowing in these districts is mostly of short duration, that is, for two months or less. Presumably the reason for this lies in the more rapid decomposition of stubble during the moist summer, as opposed to its slower destruction in the southern areas where the hot season is dry.

In many of these northern areas no superphosphate is used. The farmers state that, although such dressings may expedite the ripening of the crop by a week or so, there is no difference in the quantity of the yield. Chemical analyses of one or two of the soil types have indicated a sufficiency of phosphates, but whether this state of affairs applies generally is not known. Such a feature reduces production costs, but it is clear that it cannot be expected to continue indefinitely. Varieties of wheat which combine the factors of high yield and resistance to rust have been bred or introduced in recent years, so that the modern farmer has less to fear on this score than had his predecessor.

The soils of these districts vary widely. There are true black-soil plains, comparable with the chernozems of Russia, but for the most part these are located in a zone in which rainfall is precarious for wheat-growing. In addition, many of them are of the very heavy type, which is extremely intractable when wet. They are, therefore, little used for wheat, although the most successful wheat-growers of the Darling Downs are on a particularly fertile type of this soil, which is easily worked. For the most part, the wheat is grown on the more fertile loams. Heavier soils are usually left under pasture. Lighter types are infrequent and, as the natural vegetation is usually of the Brigalow scrub type, the difficulty and expense of clearing cause much of this country to be left alone. Erosion is a fairly serious problem on the fallows being prepared for wheat, as heavy thunderstorms are frequent in this district during the summer months and in some seasons great damage has been done.

The extent to which wheat-growing will expand in these regions is problematical. The development of effective methods is a recent growth, and, from the modern standpoint, the area is a new one. Again, the lack of a detailed soil survey makes it impossible to discuss the problem in quantitative terms. It seems quite clear that a considerable extension of the wheat belt westward is not unlikely to prove satisfactory. In Queensland, the allocation of blocks to returned soldiers and others in the Cecil Plains, Jimbour, and Mount Abundance schemes on the Darling Downs, in some of which

wheat-growing was part of the contract, had to be reviewed in 1931-32.[11] The obligatory clause was removed, and land values were written down. At present the men farming good soil with modern methods are enthusiastic; those on worse soils are not so certain; those who adopt old-fashioned methods, and take few precautions, regard wheat-growing as a gamble, which it certainly is if undertaken in such a way.

Other Districts (Figs. 51, 53)

Wheat-growing is also undertaken, usually on a relatively small scale, by many farmers in districts which are not included in the wheat belt proper. For instance, in Victoria there are few counties in which no wheat is grown, while the same might be said of the tablelands of New South Wales. During the period 1940/41-1944/45 the average Tasmanian acreage under wheat was 5,000 acres and the average production 114,000 bushels. In Victoria, the north of the Western District, the plains behind and to the west of Melbourne, and a low-rainfall area round Sale, in Gippsland, have all grown considerable crops from time to time. Such regions produce a wheat of relatively low baking strength, and for the most part the soils require careful treatment if fertility is to be maintained. In the event of a serious curtailment of world wheat supplies, and resulting high prices, fairly large areas of such country could be developed on a mixed farming basis. Costs are relatively higher than in the true wheat country. The most appropriate rotations require investigation, and special varieties are desirable. For the present, the land is probably as remunerative under sheep, with occasional cropping to oats or barley, as it would be if it were used for wheat farms.

Enough has been written here to indicate the very wide variety of conditions under which wheat is grown in Australia. In many districts the industry is immature, in some it is 'slap-dash', in others it is efficient and well-organized. Comparisons are dangerous, but it is clear that there is no vast expanse of soil wholly suited to wheat-growing comparable to that which occurs in parts of North America, the Argentine or Russia. Special soils of various types, often in widely-separated districts, are most productive; intervening country is less so and, in many cases, unsuitable for the crop.

Ultimately the standard of living which can be reached by the farmers will be the criterion. During the period 1928-43 few wheat-growers were able to do more than maintain themselves on a very modest standard, unless they were on good land and relatively free from debt. Sociological surveys have been infrequent, but a study of representative wheat farms in Victoria, carried out by A. J. Holt in 1944,[12] did not give a reassuring picture. Farmhouses were often poorly equipped, the opportunities for a full life

11. *Reports of Land Administration Board* on the districts concerned (Govt. Printer, Brisbane, 1932).
12. Holt, A. J., *Wheat Farms of Victoria—A Sociological Survey* (Melbourne University Agricultural School, 1946).

somewhat meagre judged by modern standards. The farm population was found to be fairly static and most owners or operators were born on the farms themselves or in adjacent district. Hired labour was rare except for occasional periods at harvest time. In other states the position at that date was probably no better, particularly in Western Australia, where the water problem is more difficult, while the proportion of more recently opened farms being larger, fewer operators have enjoyed periods of relative prosperity. How far the better prices of the last few years have enabled farmers to improve their financial position is difficult to determine, but as most districts have experienced at least one year of drought, it is probable that the progress has not been marked. Even the beneficial results of better prices for lambs during the war period have been largely cancelled by the heavy stock losses which occurred in 1944-45 in the southern part of the wheat belt and in 1946 in the northern.

3. QUALITY AND MARKETING

Since more than half of the Australian wheat crop is normally exported, its position on the world market requires some consideration. The redeeming features of Australian wheat for the miller are its high extraction and its whiteness. The average sample is remarkably clean and very uniform, except in regard to baking quality. Its capacity to yield a flour of high quality from the bread-making point of view varies from district to district, and from season to season. Insufficient attention has sometimes been given to this factor, and one or two varieties of wheat popular with farmers have proved to be poor in this respect. The problem will doubtless be solved in due course, and there seems to be no reason why the average quality of Australian wheat should not be as good as or better than the average quality of Argentine and European wheat. Provided there is some improvement in protein quality, the wheat will continue to satisfy the requirements of European millers for a large proportion of their wheat mixtures. It is, however, unlikely that Australia will be able to produce any great quantity of grain comparable in gluten quality with the hard, red wheat of northern America.

Shipments of grain to Europe are sold an a 'fair average quality' basis. Those to the Orient are sold on specification, backed by a government certificate, issued on inspection at the port of loading. The former system is relatively simple in theory, but somewhat inadequate in practice. In each state a separate f.a.q. sample is arrived at annually. Aliquot samples from each wheat-growing district are bulked and carefully mixed; the bushel weight of the bulk is then ascertained with scrupulous care. Sub-samples from the bulk are then sent to each important purchasing centre for reference in case of disagreement over the quality of any consignment. The official samples often do not arrive until a large fraction of the crop has been sold, and it is commonly stated that little or no reference is ever made to the

bushel weight in cases of dispute, attention being focused instead on percentage of rubbish and on the opacity and colour of grains. The f.a.q. method ignores protein quality and quantity, and is, therefore, of little use as an indication of 'baking strength.' This may be of little significance to the British miller who is using Australian wheat as a filler and relying on North American wheat for protein quality; but the system is disadvantageous to the Australian millers, who, as a result, find it necessary to buy part of their requirements direct from farmers in special districts where quality is usually high. Though the f.a.q. system is faulty in many respects, it is very simple, and serves as a fair standard, always provided that the samples from which it is mixed are accurately drawn. The fact that nearly all Australian wheats fall into one category means that there is no need for a complicated system of grading, such as that which prevails in North America. At present there is little prospect of a more efficient system being installed owing to the expense which would be involved and the fact that it is not clear that a higher price would be received as a result of its installation.

Until the inter-war period the grain was shipped in three-bushel sacks; now bulk handling has gradually come into vogue. New South Wales took the lead in this matter about thirty years ago, and now possesses a silo system managed by a state-controlled Elevators Board. Western Australia installed a simple silo system, which is managed by trustees on a non-profit basis, and in 1935 Victoria erected a silo system to serve most of its wheat areas.

The marketing system has been the source of much controversy. During World War I the lack of shipping space made it imperative for the Federal government to acquire the wheat and sell it to the best advantage. For this purpose, compulsory pools were formed. It was a trying time; tonnage to lift the crops was scarce, and accumulation took place. A mouse plague caused serious losses in many districts. Farmers were loud in their criticisms; and, when normal times returned, there was a demand for the reintroduction of free marketing. Compulsory pooling was rejected by a ballot in 1921. The pools continued as voluntary organizations, but were generally unsuccessful, and their influence gradually dwindled, except in Western Australia. It was only natural that they should experience difficulties during the period 1923-29, when the general trend of wheat prices was downwards. The competing system of private wheat exporters was mainly in the hands of three firms, two of which had extremely wide ramifications. Each of these organizations and the local pool had an agent at most sidings in the wheat districts. Under the bag system, the agent accepted wheat for immediate sale or 'on storage' and the firm made an immediate payment in advance. The farmer could then decide when to sell the wheat, the receiving firm being bound to quote a price on any day. The price naturally bore some relation to the official price at ports, but it need not be the parity of that price.

Under the silo system, warrants were issued, and could be sold or held, at the option of the farmer.

In general, the Australian grain-seller was in a difficult position. Tramp tonnage was seldom available in quantity, and usually had to be chartered on estimates made some months ahead of shipment. If the European markets were slack, and the shipped cargoes reached European waters unsold, the seller either had to run the risk of incurring considerable charges or reduce his price to the purchaser. It is commonly stated that, owing to the integration of milling interests, the number of purchasers in Britain had been reduced to a very small dimension; and at times the representatives of these firms were able to hold off buying until the price of the near-at-hand shipments could be 'slaughtered'. Under such circumstances, covering operations on the option market became essential; but, naturally, these added to the cost, and the cover was not complete, because the prices of Australian wheat and option wheat did not necessarily move in unison.

At times a considerable quantity of Australian wheat is exported as flour. During the depression the Commonwealth became, for a few years, the leading flour exporter of the world. Australian milling capacity is sufficient to supply more than double the home market. This circumstance was of special value when wheat was difficult to sell. It had the advantage of placing the Australian product in a number of markets which otherwise it would not have reached. To some extent the Australian public assisted in this export by paying a higher price for local flour than was received for much of the export. This, however, did not affect the farmer, who sold to the miller at the export price—or possibly above it, if he was growing a special premium wheat.

World War II saw a repetition of the Commonwealth control of wheat marketing and it will be interesting to see how far history will repeat itself in the subsequent reinstatement of private marketing systems. One new factor in the situation is the general realization by leaders in the industry that some measure of international organization of world wheat markets is essential if a return to disastrous prices is to be avoided in a few years. In the event of agreement being reached, it seems likely that the Commonwealth government will have to exercise its powers under Section 51 of the Constitution as regards external trade. The way in which this power can be exercised with due respect to its lack of power to control interstate trade under Section 92 —a deficiency which the nation has refused to rectify at several referenda— remains to be seen.

Chapter VIII

THE DAIRYING INDUSTRY

1. The Evolution and Present Development of the Dairying Industry
2. The Efficiency of the Herds
3. The Problems of Dairy Pastures
4. The Feeding of the Dairy Herd
5. Factory Organization and Quality of Butter Produced
6. Economics and Price Manipulation
7. Minor Forms of Dairy Production

CHAPTER VIII

THE DAIRYING INDUSTRY

1. THE EVOLUTION AND PRESENT DEVELOPMENT OF THE DAIRYING INDUSTRY

IN its initial stages, as in all countries, the industry was essentially a local one (see chapter II). The suburban districts provided milk for cities, and more remote farms sent in butter when transport was available. Cheese was also made in some localities. The market price for butter and other dairy produce fluctuated widely from season to season, according to the amount of feed available for the cows. As already noted (pp. 28 *et seq.*), the industry was transformed during the closing decade of the last century and a great phase of expansion took place; it even spread into the tropics and ultimately reached the valley of the Daintree near Cooktown in latitude 16° S. One great advantage which the Australian exports have always had has been due to the fact that the peak period of dairy production in Victoria and southern New South Wales naturally coincided with the spring flush of growth in the pastures (September-November), and gave a surplus which could arrive in Britain just when winter had curtailed the European output. Consequently, there was a good overseas market for the Australian excess in countries prepared to accept such imports.

The high price of dairy products at the close of World War I hastened the transfer to dairying of some of the better-class sheep land in areas of good rainfall, such as the Western District of Victoria. The development of irrigation also carried dairying inland into country normally too dry for the industry to thrive, but it could only expand in those areas where water rates are low.

The onset of the economic depression of 1930-34 was followed by an expansion in the dairy industry, as Figs. 8, 9 and 10 show. This was partly accounted for by an increase in the number of cows kept in districts not primarily concerned with dairying. Families living on wheat farms found themselves faced with a partial or even total loss of income. They thereupon turned to the cow as a ready means of acquiring a little cash for necessities. Another reason for the increase in production was a steady campaign for pasture improvement in southern areas; this gave more and better feed for the cows.

The decline in butter production from 1940 onwards was in part due to the diversion of milk to other dairy products, such as cheese, for wartime purposes, and in part to the difficulties of obtaining labour which caused some farmers to give up dairy herds and turn their attention to cattle production.

Effective commercial dairying is largely confined to the higher rainfall regions of the continent which are near to the coastline in the eastern states, and in the south-west corner of Western Australia. In Tasmania the north-western areas are of primary importance. In addition to these regions dairying is also practised in the irrigated inland areas, especially in Victoria. The industry can be grouped into two parts—summer rainfall and winter rainfall regions. The former includes all dairying districts of Queensland,

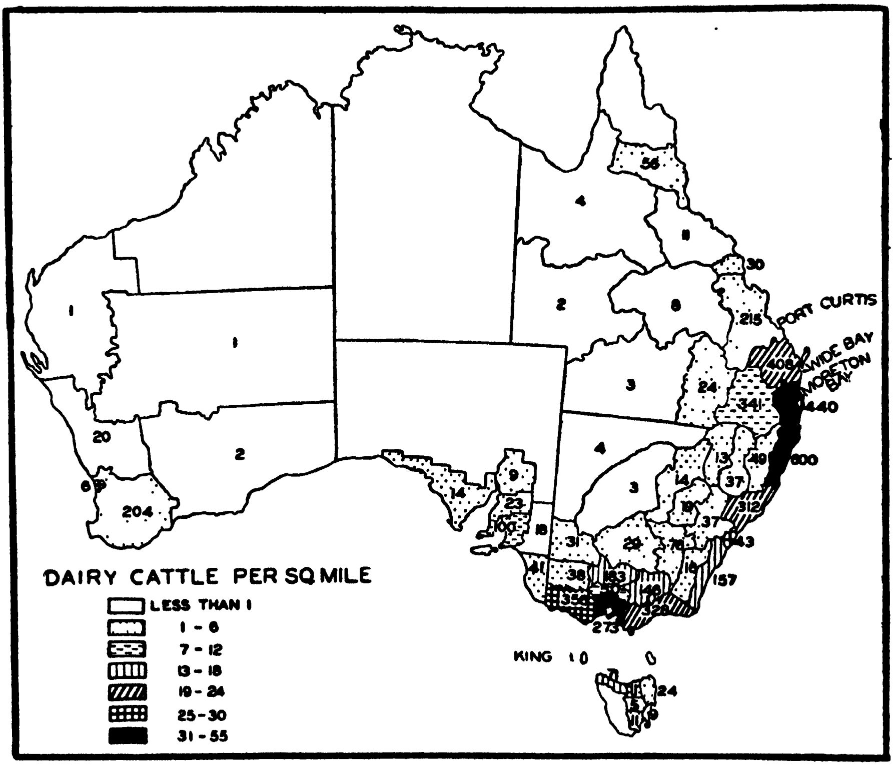


Fig. 54. Distribution of Dairy Cattle by statistical regions

N.B.: No attempt is here made to designate geographic distribution in detail
Figures indicate number of dairy cattle in thousands
Average 1943-45

and the northern part of New South Wales, the rest of the industry being located under winter rainfall conditions. Fig. 54 shows the approximate distribution of dairy cattle by statistical regions; most of those kept in dry inland areas (apart from those in the irrigated districts) provide supplies of milk for the farms themselves or for adjacent towns.

Queensland has the largest number of dairy cows among the various states, but milk production per cow is relatively low. In this state the sharp drop in rainfall beyond the Great Dividing Range confined the industry

almost entirely to the coastal regions, the exception being the Darling Downs area, where dairy cattle density is relatively high (Fig. 54). Generally speaking, the number of specialized dairy farms decreases from the seaboard to the inland and along the coastal areas from the south to the north.

The coastal dairying areas, like the Moreton Bay region in the south and the Atherton Tableland in the north, have an abundant rainfall. In both these regions dairying is moderately specialized. In the former the Brisbane market for whole milk exercises an important influence. In the Tableland the costs of scrub-felling and lack of developed by-roads have retarded the development of the farms. It is planned to utilize the hydro-electric power of the area for farm electrification to a much larger extent than at the present.

Between Moreton Bay and the Atherton Tableland are two other areas where dairying is practised, sometimes on a mixed-farming basis. In the Wide Bay districts dairying is partly associated with maize, peanuts or other crops, and in the Port Curtis district with cotton or with sugar-cane. In the latter, good stock water supply is frequently difficult to obtain, the underground water being too salty for the stock.

The Darling Downs region contains about one-third of the total dairy farms of this state, but relatively few are wholly devoted to dairying, other products being wheat, sorghums, and cattle. Water supply is usually obtained from bores and wells and the farming is mainly arable. Better feed and freedom from disease enable the cattle to develop better than in the coastal districts. The district has a reasonably cheap transport and factories which are well situated. Cheese production is a feature of this district.

New South Wales has the second largest number of dairy cows. The North Coast Division with summer rainfall carries almost half of the dairy cows of this state. As in Queensland, the dairying regions are largely confined to the coastal districts with high rainfall, but the dairying population diminishes from the north to the south. The Tablelands are generally too rugged for dairying, and here the industry is confined to areas of gentle topography. Many of the soils in the coastal regions are more or less immature in spite of the heavy rainfall; but there are large tracts of podsols, many of which are too poor for use. In the vicinity of rivers, particularly in the north and central regions, rich alluvial soils provide the most valuable dairying land. The majority of the dairy stock on the coast depend entirely on pastures with some supplementary green fodder crops. There is also some dairying on the irrigation areas. In this state, in the 1944-45 season, about two-thirds of the milk production was utilized in butter-making, and this state tops the butter export trade in quality. Cheese-making is of little importance.

Victoria. Although only third among the states in dairy cow population (27 per cent of total, 1946), this state has highest milk production (36 per cent of Australian total). Many of the existing districts were established as pioneering ventures, and in some places this phase still exists. Often the

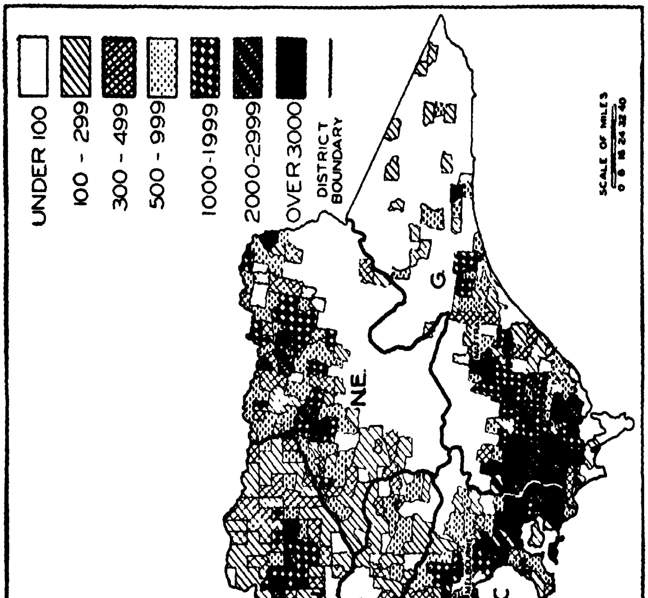


Fig. 55. Distribution of Dairy Cows in Victoria, 1936-37, by Parishes

W = Western District
C = Central District
N = Northern District
NE = North-Eastern District
G = Gippsland

pioneer has to face heavy clearing costs owing to the dense nature of the forest. He has to build up his pastures and his herd. These processes take time—the intervening years during which he is struggling constitute a period of trial, or even privation, which have proved too much for many a family. In districts with higher rainfalls invasion by blackberry, bracken and other rapidly-growing perennial weeds is a disability of great significance at this stage. It is commonly said in Gippsland that the third generation is the first to achieve a reasonable standard of success and comfort. There have been many brilliant exceptions to this generalization, but in some regions the number of derelict dairy farms is large. Doubtless a contributing factor has been the isolation of many farms by bad roads; the general building of good roads began only in 1925. The Federal Dairy Investigation Committee, in its Report in 1930,[1] estimated that, in the Strzelecki Ranges, 150,000 acres of settled land had been abandoned, and a further 160,000 acres were in a neglected condition.

An analysis of this distribution for the state of Victoria is shown in Fig. 55. In the dairying areas of Gippsland the annual average rainfall exceeds thirty inches, and in some parts is over forty inches; in the localities where the rainfall is below thirty inches, dairying is concentrated only on the irrigated land in the Maffra-Sale area. The soils vary widely; the alluvial flats have the highest natural fertility, but some of the various leached soils have also been raised to a high level of fertility through pasture improvement. The production of whole milk for Melbourne is responsible for the extension of dairying west of this main zone of Gippsland to where the rainfall is lower and the soils are not naturally good. In the Western District, while dairying is mostly confined to the higher rainfall areas, it is concentrated on the rich soils near extinct volcanic cones, while patches of river alluvium and other soils of above-average fertility occur near Coleraine. In the North-Eastern District, the industry is mainly confined to alluvial areas in river valleys. The irrigation areas of the Murray Valley carry dairy herds which provide export butter production where water is cheap, as in the Northern District (Plate 42), or milk for local consumption only, as at Mildura. In the other states the detailed distribution of the industry follows the same pattern, being governed by the same series of factors—climate, soils and proximity to urban centres.

South Australia. In this state almost half of the dairy cows are in the Central Division, mainly in the hills lying east and south of Adelaide, where the rainfall is about thirty inches. This country, although variable, with light soils at places, responds to improved management. Dairying is the dominant industry in the hills, and is often associated with horticulture or small-scale crop production. These mixed farms supply the city with whole milk and also cream for the larger part of the butter produced in this state. County

1. Part I, *Farm Production* (Govt. Printer, Canberra).

Grey in the extreme south-eastern corner, on the Victorian border, has the greatest concentration of dairy cattle in South Australia. Local farms, many of which are on volcanic soils, are mainly specialized for dairying, and the district has a reputation for cheese. Some dairying is carried on on a few farms around Spencer Gulf, while the irrigated swamps of the lower Murray River carry over seven thousand acres of pasture, used almost entirely for dairying. These swamps can produce high-grade pastures over a long period, a feature which is uncommon in this state, and is the cause of its rather small volume of dairy production.

Western Australia. In the lower south-west, dairying is often the main farming objective, although pig raising, vegetable and fruit production are sometimes associated with it. Lack of areas with good soil and adequate rainfall has prevented much dairying development, and this state still periodically imports butter from the eastern states.

After World War I, the high rainfall in the south-western corner of the state suggested that dairying might be used as a basis for immigration schemes for land settlement. An ambitious Group Settlement Scheme (Plate 44) was embarkd upon to bring people from the United Kingdom and settle them on virgin forest country in the extreme south-west. For a variety of reasons the scheme fell short of its original intentions, but by 1942 there were some 1,100 settlers on what had once been Group Settlement holdings, and an area of 145,000 acres had been cleared and developed. Areas both of heavy forest and sandy heath were used. Soil poverty with the resultant difficulty in establishing satisfactory pastures and preventing wasting diseases among the cattle[2] was one main cause of failure. More recently success has been achieved as a result of scientific investigations.

In the north-western region of *Tasmania,* and on King Island, dairy cattle are the dominant livestock. Dairying is partly specialized, partly combined with mixed farming. This is also the case in parts of the north-east of the island state and on the east coast; it is negligible in the drier Midlands, and fairly well developed around Hobart for milk supply. In the 1944/45 season nearly three-quarters of the milk production was utilized for butter manufacture.

Dairying has one advantage as a pioneer venture—it provides a regular income month by month. The farmer is not faced with a long period of waiting for some result of his labour. The obstacles to the attainment of a large output from a new farm are, however, considerable; and the work of milking cows twice a day is unattractive on account both of its nature and of its monotony; further, the process of milking and cleaning up the sheds and utensils, properly carried out, absorbs so much time that unless the family does this work the farmer has little time for other jobs on the farm. This is

2. Filmer, J. F., and Underwood, E. J., 'Wasting Disease,' *Jour. Dept. Agr., W.A.*, XIII, 1936, p. 199.

particularly so on small farms, where the number of cows kept does not warrant the use of milking machines.

At all stages of development the efficiency and success of individual dairying ventures, and, consequently, the effectiveness of dairying as a mode of land utilization, ultimately depend on a number of factors, failure in respect to any one of which may prevent progress or even involve the whole enterprise in disaster. These factors are: (i) the efficiency of the herds; (ii) the care of the pastures; (iii) the feeding of the cows; and (iv) the efficiency of operations on the farm and in the butter factory. The price received for the products is important, and is of special significance in marginal dairying areas or in regions where the farmers are struggling to establish themselves on virgin country. An examination of Australian dairying should, therefore, take the form of a consideration of these factors as they affect the various districts.

2. THE EFFICIENCY OF THE HERDS

Although the general dairy cattle population consists of crossbred and grade cows, it is, in common with those of most temperate countries, mainly built up from British breeds of stock, and pedigreed animals of almost every breed have been imported at one time or another. Each breed has its own Australian herd book, maintained in the usual way. Jerseys probably provide the most abundant basic stock in the districts where conditions are relatively favourable (Plate 43). Among the Shorthorns, a special strain known as the Australian Illawarra Shorthorn has been developed in New South Wales, and has its own herd book; and in Victoria there is a separate Dairy Shorthorn Association for animals with pedigrees derived from the British (Coates') Herd Book. Ayrshires are popular in districts where conditions are harder, while Red Polls, Friesians and Guernseys all have their supporters. The fact that payment for milk or cream is usually made on a butter-fat basis, except where city milk supply is the objective, has favoured breeds with a reputation for producing milk with a relatively high butter-fat content. The large number of district agricultural shows, and the stress laid on the great Agricultural Show associated with each capital city as a feature in the national life, have stimulated recognition of the value of high-grade stock.

So far, the general picture is satisfactory, but the details of its composition are not so pleasing. In the first place, some of the breeders have been inclined to pay more attention to show 'points' than to capacity for production. Consequently, although a pedigreed animal may have an eminently satisfactory body from the point of view of physical health, it may be of little value in a commercial dairy herd, unless it also has that genetic constitution which will lead to a satisfactory annual output of butter-fat. This problem is, of course, common to most countries where specialization in dairying exists. The breed

societies endeavour to surmount the difficulty by publishing records of productivity of certain pedigreed herds which are subject to official herd-testing schemes. A further difficulty is due to the variability of the climate and the consequent variation in the amount and nutritive value of the food of the cows. Pedigreed herds are often very highly fed, but their inherited capacity for high production will not be of great value if the animals require standards of feeding beyond the reach of the commercial dairy farmer. The following table sets out the yields for those pure-bred cows which were recorded in 1945/46.

State	No. of Pure-bred Cows Recorded	Average Production lb. butter-fat
New South Wales ..	828	341
Victoria	2,752	330
Queensland	624	Not available
South Australia . .	544	356
Western Australia . ..	393	280
Tasmania	603	300

Herd-testing among other than pedigreed herds of the various states had made some progress before World War II. It fell into abeyance during the war, but is now making progress again. Generally speaking the percentage of cows tested was not high except in the best dairy districts. The following table sets out the results of grade herd recording in the various states in 1939/40 (1938/39 in the case of South Australia).[3]

State	Cows in Grade Herd Recording Schemes		Average Production of Recorded Grade Cows
	Number	Per cent of all Dairy Cows	
New South Wales ..	39,454	4·4	160 lb. butter-fat
Victoria	84,690	9·8	261 „ „
Queensland	9,310	0·9	160 „ „
South Australia	8,920	5·5	268 „ „
Western Australia ..	11,479	9·4	208 „ „
Tasmania	7,819	8·6	224 „ „

3. In both Grade Herd Recording and Pure-bred Cow Recording Schemes the cows are periodically tested for milk and butter-fat production.

In the Pure-bred Cow Recording Schemes the animal has to be registered, or have been accepted for registration by a recognized Breed Society. Certificates are given only when the minimum annual butter-fat production is reached by the cow. This varies according to the age of the animal, and for a 'mature' cow it is 350 lb.

In the Grade Herd Recording Schemes any cow may be included. In some states, however, provisions have to be made for the use of pure-bred registered bulls, and also for the culling of the low-producing cows. In Victoria such provisions are essential only when a state subsidy is sought. Since 1 July 1945 the Commonwealth government has agreed to subsidize any approved Grade Herd Recording Scheme.

During the pioneer stage of dairying, when men are often endeavouring to establish themselves with meagre supplies of capital, the problem of building up a herd with a high yield is an acute one. The only readily available supply is from the open market, where many of the animals on offer are the rejects from other herds. Many dairy farmers develop the idea that they have insufficient land to breed their own stock. To such men, the function of the bull is merely to put the cows in calf; bull calves are usually sold for slaughter, and heifers are, for the most part, sold as soon as practicable. Any bull is good enough for this work, and, consequently, many of the heifer calves on the market are of low quality. In some states subsidies are paid to purchasers of pure-bred bulls to encourage the use of satisfactory animals. This, and a general realization of the need for higher production, has led to an improvement in recent years. In some cases the price paid for the young bulls has been based on the butter-fat records of their dams. Recently, appreciation of the further fact that even the use of pure-bred strains does not always lead to improvement, or even maintenance, of productivity, has caused the adoption of a scheme of 'bull indexing'[4] on some of the larger dairy farms. Some attempts are being made at artificial insemination using indexed bulls, but they are only in the experimental stage.

The need for a general system of culling the progeny of dairy herds is a very real one. It follows that this need places a limit upon the rate at which a dairy industry can expand with efficiency. If it be assumed that a cow or heifer produces a calf every year, then about half of the calves will be females. If no culling is done, and every heifer born is added to the dairy cow population, the number of cows might be doubled in two years, apart from wastage. If efficiency is to be kept at a level above the minimum, culling is essential both in respect to general physique and to capacity for production. Assuming that half the heifer calves should be sent to the butcher, then the cow population could be doubled in four years, or, allowing for wastage, in six. As intensity of production increases, the necessary rate of culling should be higher.

Reference to Figs. 8, 9, and 10, chapter II, shows that the rate of culling must have been dangerously low in the different states at various times. In the four-year period, 1903-07, the Queensland cow population increased by over 150 per cent, so that little or no culling could have been done. In New South Wales, the cow numbers doubled between 1902 and 1906, while both in Victoria and Queensland the rates of increase between 1930 and 1935 were high. As the data presented are for all cows in the states, and a growth in the cow population represents an increase principally in commercial dairy cows, it may be assumed that the rate of culling has often been too low for the maintenance of efficiency in production.

4. Under this method young bulls are tried out, and the production of a number of their heifer calves is examined, before the bull is used as the general male parent in the herd. The subject is becoming a live one among the more progressive farmers.

Disease among dairy cattle is another factor of prime importance. Tuberculosis is present, but is usually not as serious a factor as in those dairying countries where the animals are housed during winter. In certain districts it is a source of loss, and the percentage of cows affected in Victoria is estimated at about three per cent. The introduction of a self-supporting compensation scheme in Victoria has been helpful, as farmers have been more ready to report suspected animals than they otherwise would have been. The cows providing whole milk for certain cities are periodically tested. Contagious abortion is prevalent, and at times plays havoc with the productivity of individual farms. The tendency to buy cows on the open market has probably served to spread this trouble unduly. An investigation of the disease was made by officers of the Veterinary Service at Glenfield Research Station, New South Wales, the finance being provided in part by the industry itself. Mastitis is also frequent, and detailed research in this disease has been made in Victoria under the auspices of the C.S.I.R.[5] In Queensland dairy districts the cattle tick causes considerable loss unless protective measures are undertaken. The latest methods of control using DDT are most promising and seem likely to check the further spread of this pest and also to be effective against the buffalo fly (*Lyperosia exigua*) which has spread southwards at an alarming rate in the last five years. Pleuro-pneumonia[6] occurs infrequently, and only in some districts; it is rarely serious in extent. Recent research into this disease inspires hope that more effective control may be obtained in the near future. Foot and mouth disease, the periodic curse of so many dairy countries, has been excluded by effective quarantine precautions.

3. THE PROBLEMS OF DAIRY PASTURES[7]

A bold statement that satisfactory dairying is seldom achieved in districts where native pasture plants form the bulk of the herbage would be immediately challenged by many Australian dairy farmers. Nevertheless, it is approximately true for many districts, as the following theoretical considerations will show. Wherever rainfall was heavy enough to support forest, the original growth of timber and bush was so great that herbaceous types of plants were scanty, and those which did exist were shade-loving species. When the forest was cleared, new plants had to be established, and these were almost always introduced species. Native species from drier districts did invade these areas at a later date, but the majority of such plants are suited to a dry climate, and are incapable of making the most of the higher rainfall. It is true that, where dairying has wrested land from a

5. Murnane, D., 'Studies on Bovine Mastitis,' *C.S.I.R. Bulletin* No. 134. Murnane, D., 'Clinical Bovine Mastitis, Its Treatment and Control,' and Hindmarsh, W. L., 'Clinical Bovine Mastitis and Its Treatment,' *Aust. Vet. Jour.*, Vol. xxii, No. 5, 1946.

6. Turner, A. W., and others, 'Studies on Contagious Pleuro-Pneumonia in Cattle,' *C.S.I.R. Bulletins* Nos. 93 and 97.

7. A concise description of the dairy pastures state by state is to be found in the report of the Federal Dairy Investigation Committee, Part I, *Production*, pp. 30-59 (Govt. Printer, Canberra).

purely pastoral occupation, native grasses sometimes form the bulk of the pasture; but, in general, this transition only occurs on the better soils, and, if suitably fertilized, these will usually support the more luxuriant growth of introduced forms. In some of the dairying areas of New South Wales and Queensland the bulk of the herbage is of native species, but they are the exceptions, and it is probable that, with the greater attention which is now being given to pasture improvement, they will conform to the general rule in the next few decades.

Australia has drawn her dairy pasture species from all parts of the world. Among the grasses, Europe provided Cocksfoot (*Dactylis glomerata*), Perennial Rye Grass (*Lolium perenne*), Kentucky Blue (*Poa pratensis*), and many others; America gave Couch (*Cynodon dactylon*) and Golden Crown (*Paspalum dilatatum*), while Kikuyu (*Pennisetum clandestinum*) and Rhodes Grass (*Chloris Gayana*) came from Africa. Of the clovers, Perennial White, Red, Alsike, and Strawberry were European. Subterranean Clover came apparently from the Mediterranean region, and lucerne is almost world-wide in its cultivation. Each of these species has its own range of soil and climatic types in Australia, and farmers have been quick to appreciate the value of useful introductions. Sometimes they have been too hasty, and there have been numerous instances in which various species have been expected to live under conditions of soil and climate to which they were biologically unsuited. However, pasture knowledge is increasing rapidly, and brave but foolhardy attempts to develop unsuitable pasture types are becoming less frequent. The great weakness of many dairy farmers is their failure to appreciate the drain on soil nutrients exerted by a luxuriant pasture grazed by deep-milking cows. English farmers learnt this lesson a hundred years ago, but their Australian brethren, dealing with new soils, often initially rich in stored fertility, failed to realize that such fertility could not last indefinitely. The last fifteen years have seen the awakening of a 'pasture conscience' in many southern districts. Every year sees a wider appreciation of the importance of soil fertility to pastures and of the need for greater understanding and control of the grazing of paddocks, but there is still room for considerable improvement in this respect.[8]

In most dairy areas the commonest soil deficiency is that of phosphate, and top-dressing with superphosphate produces its usual satisfactory result. In northern New South Wales and Queensland, experiments in the use of phosphate have in some cases been less successful, especially on red soils where phosphate may be fixed in a highly unavailable form. On certain of the poorer types of soil in southern Victoria, potash deficiency has been demonstrated after heavy grazing for a few years. In some areas where soils are poor, lime deficiency occurs.

8. Some aspects of these problems are referred to in the *Sixth Report of the Rural Reconstruction Commission*, para. 1199, page 107 *et seq.* (Govt. Printer, Canberra).

Following on researches in Britain and New Zealand, intensive work on various aspects of pasture plants in Australia has also demonstrated the importance of strains within the species. In a number of species the seed of certified strains, grown under government schemes of inspection, is available and farmers can now be sure of the quality of the seed which they buy. The progress of recent years has been considerable, but there are still wide gaps in our knowledge; for although the principles were evolved overseas, the detailed knowledge of the inter-actions of types of plants under their special local conditions can only be gained in each locality. There is some need for experimentation on a wider basis; for instance, no serious attempt has yet been made to adopt the 'moving bail' system of dairying for Australian conditions despite the fact that it seems most suitable on poor soils. Again, in some districts where permanent pastures gradually deteriorate, little attempt has been made to devise a mixed, arable pasture system of dairy farming.

4. THE FEEDING OF THE DAIRY HERD

Although the capacity of the animals, and the presence or absence of disease, are important factors in maintaining effective dairy production, the nutrition of the animals is of equal, or possibly greater, significance. The amount of attention given to this matter by dairy farmers varies enormously. The ideal state of affairs would exist if the growth of the pastures were sufficient to keep the herd in full production throughout the year. Such an ideal rarely, if ever, exists. In most districts there is a marked flush of productivity at certain seasons. Unfortunately, quantitative data on pasture growth are not generally available. In certain special localities in Victoria careful experiments, conducted over a period of years by the state Agricultural Department, and financed largely by the Victorian Pasture Improvement League,[9] have brought to light many facts in connection with manuring, in addition to determining the actual bulk of feed which may be expected from the pastures concerned. The plots were all located in districts which would be described as dairying areas, and yet the variation in productivity was found to be considerable. Results over a period of five and a half years for four centres, Caldermeade and Korumburra, in Gippsland, Larpent and Cobrico, in the Western District, are shown in Fig. 56. The curves, which are greatly smoothed, are for pastures given effective manurial treatment; these curves and those for the remaining six stations, all show similar form—a marked spring flush of growth rising to a peak, usually in October or November, and then falling rapidly with the onset of the hot, dry period of the summer. The autumnal production (March to May) is usually low, but may be fairly good in the event of heavy summer and autumn rains. During June, July and August, the mean temperature of fifty degrees restricts the growth of pastures in these districts.

9. See reports in *Jour. Dept. Agr., Vic.*, from 1933 onwards.

These smoothed curves indicate roughly the average productivity per acre per day in terms of dry matter. About 30 lb. of such material is required daily to satisfy the stomach of a cow, but here no account is taken of the quality of the fodder. If the stocking rate were two acres per cow, an average production of 15 lb. of dry matter per day would mean that theoretically they could be fed on the paddocks all the time. As the area per cow increases, it becomes more difficult for the animal to collect the necessary amount of herbage during the day, and, consequently, she tends to lose condition, and production declines. The extent to which the production of a district falls below this figure at any time measures, very roughly, the extent to which hand-feeding becomes necessary. The extent to which hand-feeding is economically justified is debatable, and must depend on the efficiency of the cow as a producer as well as on the cost of conserving or buying food and on the value of the product.

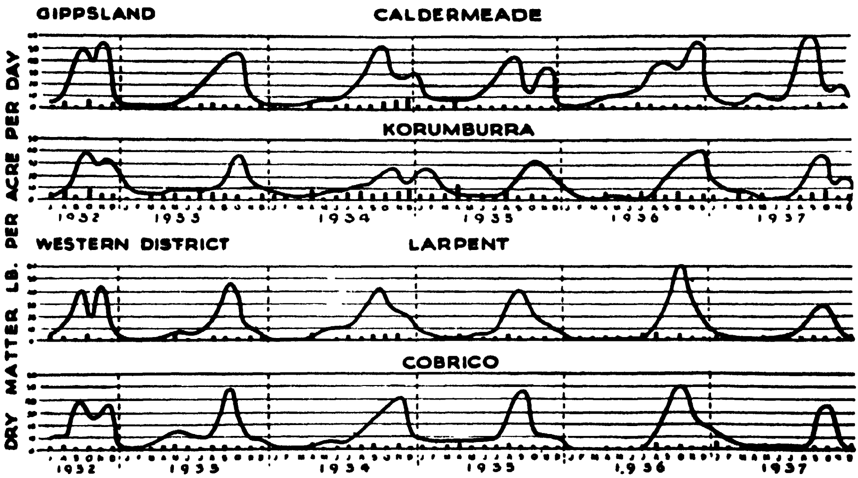


Fig. 56. Diagram illustrating Seasonal Growth on Dairy Pastures at four centres in southern Victoria, 1932-1937

The period during which hand-feeding is necessary varies widely from place to place and from year to year, but, theoretically, it is seldom less than six months. The problem is attacked in various ways. In all but the best districts the summer shortage is largely overcome by grazing some of the paddocks only lightly during the spring flush. The grasses run to seed, and remain as roughage for the next few months, and there is usually enough scattered green growth to enable the cows to digest this material. This rough-and-ready method of management is not in accord with intensive

systems of pasture treatment found in some other countries, but it is probably an effective compromise which suits this particular Australian environment. Its danger lies in the deterioration of the pasture composition which takes place where aggressive species are included.

The autumn and winter periods present more difficulty. In the old days many dairy farmers relied almost entirely on the cultivation of crops to

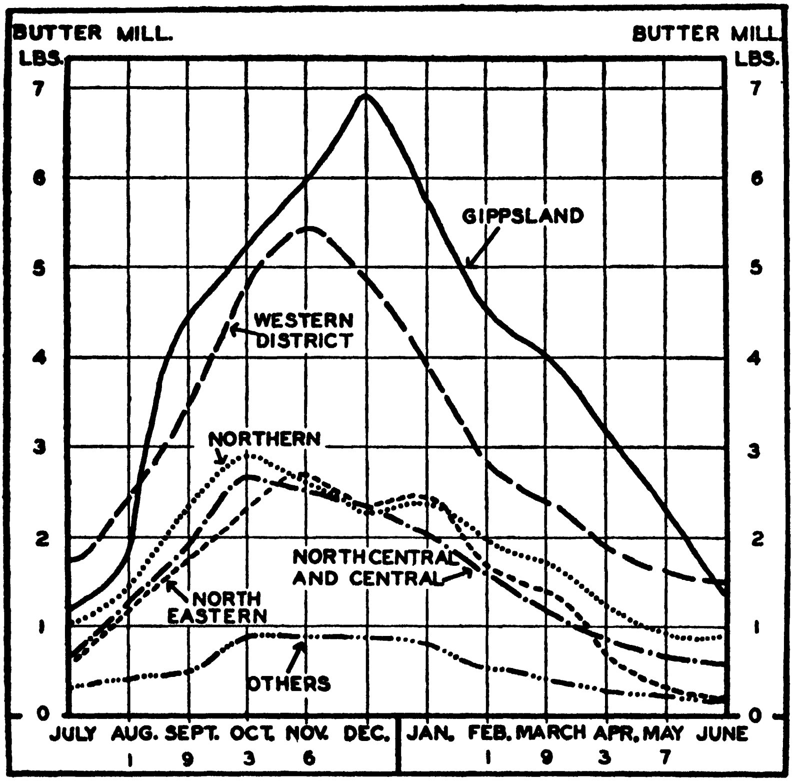


Fig. 57. The Seasonal Nature of Butter Production in Victoria

The output of the butter factories in each district of Victoria is here shown in graphic form. The more even production in the 'Northern' District is attributable to irrigation.

provide the necessary foodstuff. Maize, millet, sudan-grass, sorghums and oats were all grown, and either fed off on the paddocks, or cut green, or turned into silage for the cows. The advent of pasture improvement has allowed a great increase in the amount of grass hay or grass silage conserved, with a corresponding reduction of the amount of cropping.

This outline of pasture productivity, and the problem of filling the cow's stomach, has been given for southern Victoria, because it was possible to sketch the position in quantitative terms. In other districts the same problems emerge

in various guises. In those irrigated dairying areas where soils are suitable, and good pastures have been established, productivity can be continued at a high level during spring, summer and autumn. Such areas are among the most productive. On the other hand, in the northern dairy areas of New South Wales and in Queensland, summer rains predominate, and lack of moisture in winter and spring is the factor inhibiting production. Here the pastures are dominated by different species, Paspalum and Rhodes grasses being the most frequent. Pasture management seems to present special obstacles, haymaking is rare owing to the wet summer, and silage is seldom made. As a result, the seasonal nature of production is marked. In northern Queensland, where dairying only occurs on the high rainfall areas of the coastal belt, the problem of pasture plants and their effective management, so as to check invasions from coarse invading species, has scarcely been solved. On the Darling Downs cereal crops are often grown as subsidiary fodder for cows during the off-season of pasture growth. In some parts of both South Australia and Western Australia dairying is carried on with pastures of annual plants, notably subterranean clover. These die in the late spring, but the dried plants lying on the ground furnish the main source of food for the cows during the summer. The absence of rain probably prevents this material from losing its nutritive qualities, as it would in moister districts; occasionally, lucerne is available in small quantity. The capacity of cows to continue giving milk on such fodder is surprising.

Although farm-made reserves are the mainstay of feeding in the off-season, some supplementary foodstuffs are purchased. The Australian dairy farmer is not confronted with the wide array of cattle 'cakes' to which the English producer is so well accustomed. By-products from maize, cotton and linseed are usually available in small quantity, and bran is used in considerable amount, and the use of crushed wheat came into vogue during the period 1942-44 when the grain was cheap and the need for dairy products great. But there is no question of feeding large amounts of such materials, nor was such a practice economically justifiable before the recent war in view of the fact that the price of butter-fat was usually about 1s. per lb., and at times considerably less. At present there is no certain knowledge either as to how far the amount of supplementary feeding with concentrated foods takes place, or as to how far it could take place with satisfactory economic results. In some districts, the matter is receiving more attention than formerly, while in others the nutritional requirements of the cows receive but scant consideration and periods of scarcity are met partly by drying the cows off, partly by allowing them to lose condition, and occasionally by sending them away on agistment to some other area, where the feed available is often of the poorest quality.

Much, therefore, remains to be done before the production side of the Australian dairying industry as a whole can be regarded as efficient. Progress

in recent years has been steady; the attitude of the farmers themselves is undergoing a slow change, and today the numbers who are in search of more information and guidance from scientific sources are steadily increasing. It would be unfair to expect the farmers to shoulder all the blame for their tardiness in adopting efficient methods, since it must be remembered that accurate pasture experimentation and knowledge are the product of the last fifteen years, and, until recently, there has been a definite shortage of trained pasture experts. On the side of animal nutrition, there is still a marked lack of men with an accurate knowledge of how to apply scientific principles of animal nutrition under the special circumstances of the dairy industry in Australia.

One of the main difficulties of the industry is the presence of many herds which are scarcely large enough for economic use of labour. A farm which will only carry thirty cows or less is not large enough to employ two men if machines are used for milking; consequently, family labour is frequent on such farms. Nor is such a unit large enough for the practices of efficient mechanized haymaking, while contractors for such work are scarce. Finally, in the endeavour to carry as many cows as possible the farmer usually does not rear his own calves but relies on buying cows at the local market. The result is that living conditions on some of the farms are unsatisfactory.

5. FACTORY ORGANIZATION AND QUALITY OF BUTTER PRODUCED

A modern dairy industry cannot claim to be efficient unless its factory side is effectively organized. When the factory system started in the 'nineties, roads were bad, and cream could be readily collected only over limited distances; consequently, the factories were small and numerous. As time went on, some amalgamation occurred, some factories dropped out, and, in other cases, competitive organizations set up in business. Today there are about 500 butter and cheese factories in the Commonwealth, distributed as follows:

State	Number of Butter, Cheese and Condensed Milk Factories in 1943-44	Average Annual Output for 5 Years ended in 1942-43	
		Butter (in million pounds (factory and farm))	Cheese (in million pounds (factory and farm))
New South Wales	117	106·3	6·3
Victoria	152	143·6	22·0
Queensland	99	106·2	17·3
South Australia	47	21·2	19·1
Western Australia	17	16·0	11·5
Tasmania	40	10·9	3·0

Computed from *Commonwealth Year Books* and *Produce Bulletins*.

It is noticeable that the number of factories in Victoria is much larger than in the other two states of large dairy production. It may be questioned whether the competition between these installations has not exceeded the limits of efficiency. In an Act of 1935 the Victorian parliament refused to permit the erection of additional factories without ministerial sanction. The problem is by no means simple, because, during the flush period of pasture growth, every factory is working to capacity (Fig. 57). The difficulty managers have in obtaining sufficient supplies during the 'off' seasons to keep down their costs of operation tempts them to questionable methods of competition. Some factories draw their cream from wide areas, bringing it through zones normally served by other factories. This waste of effort was avoided by compulsory zoning during the recent war, but emerged again soon afterwards. In South Australia, for instance, city factories compete with local factories for cream supplies and offer free rail transport, with the result that cream may be carried 150 miles to Adelaide. It is also frequently stated that undue leniency is sometimes exercised in the matter of grading cream, so that suppliers shall not be offended. Most of the factories are co-operative in name, but the competition often seems to be as fierce between them as it is between those owned by proprietary firms. How far these practices lead to any serious increase in manufacturing costs is impossible to say, as no thorough economic examination of the industry has ever been made. Probably the direct result is relatively unimportant, but at times it leads to an unhealthy condition of rivalry rather than to a state of common and progressive efficiency.

The question of quality in Australian dairy products is a difficult one. The presence of pioneer dairy farms with relatively poor equipment for the handling of the cream, is one source of trouble. On some farms the supply is not entirely satisfactory. The widespread nature of the industry leads to infrequent collection of the cream in some districts, and the high average temperatures which prevail during part of the year intensify the difficulty of maintaining quality. It is, therefore, not surprising that a considerable amount of the butter made does not reach the standard of 'choicest'. For many years boric acid was used as a preservative, and masked the defects to some extent. When this was prohibited by law it became necessary to redouble precautions against deterioration. The long period of cold storage which much of the Australian production has to face during its journey to the British market emphasizes this need. This lengthy period between manufacture and consumption also affects the type of butter which can be made. During the boric acid regime it was possible to export 'high acid' butter of the Danish type, but this became impracticable when preservatives were prohibited. To some extent, this has restricted the range of the markets in which Australian butter finds favour, since it is generally agreed that Scotland and the north of England prefer the more highly flavoured article. In recent years the

C.S.I.R. has set up a dairy research organization which has made special studies of the technical problems associated with the keeping quality of butters in cold storage.

In the long run, quality in dairy products depends on the relative cleanliness and efficiency of every piece of equipment which they touch, and on the design and construction of each building in which they are treated. At every stage, from the cleanliness of the cow's udder before milking begins, to the conditions in the grading-room where the butter is examined prior to going into refrigeration in the ship's hold, watchful care is essential. Cleanliness is a matter of equipment on farm and in factory, coupled with the education of all those concerned in the handling of these products. Active campaigns are waged, both to ensure a high standard of equipment and also to educate the workers; but there are still some districts in which the supervision of dairies is not completely satisfactory, and there are still some factories in which the equipment and methods could be improved. The difference in prices paid to farmers for 'choicest' and 'first-grade' cream is usually a penny a lb. or less. Some farmers do not consider the difference worth worrying about.

It is pertinent to add that the difference between the prices realized by 'choicest' and 'first-grade' qualities of Australian butter before World War II was often only of the order of 1s. per cwt. This suggests that either the scheme of allotting grades was out of step with the market requirements, or that the whole system by which Australian butter is sold in London requires review. One explanation is that much of this butter is reworked and blended either with other butter or with margarine and that for these processes minor variations in texture are not important.

6. ECONOMICS AND PRICE MANIPULATION

The high prices which dairy products brought during World War I and up till 1921 caused a marked expansion in the industry. The ensuing decline in prices found many dairy farmers in the early stages of establishment, and, consequently, not in a position to withstand a period of decreasing returns. After considerable discussion, lasting over several years, a voluntary scheme of price control, known as the Paterson Plan, was introduced in 1926. Under this scheme every participating factory agreed to contribute to a common pool the sum of 1½d. for every pound of butter it produced. The total of this pool, less administrative expenses, was then distributed over the butter exported from participating factories in the form of a bounty of 3d. to 4d. per lb. Naturally, the scheme could not be enforced without the introduction of a tariff to prevent importations from New Zealand. This tariff was 6d. per lb. in 1927. In 1929 the scheme was extended, and the levy was raised to 1¾d. The ratio of export to locally-consumed butter is shown in the following table, together with the corresponding London prices.

BUTTER

	Production in million lb.	Local consumption in million lb.	Net export in million lb.	Ratio local consumption to nett export	Average London price for Australian choicest salted butter per cwt. (sterling)
1925-26 ..	273	178	98†	1·8	184/–*
1926-27 ..	253	183	77	2·4	169/6*
1927-28 ..	281	188	99	1·8	169/6*
1928-29 ..	291	187	102	1·8	171/–
1929-30 ..	300	191	108	1·7	153/–
1930-31 ..	351	187	163	1·1	116/–
1931-32 ..	391	189	202	0·9	104/6
1932-33 ..	420	193	226	0·9	86/6
1933-34 ..	452	207	244o	0·8	78/–
1934-35 ..	470	207	263	0·8	75/6
1935-36 ..	434	222	212	1·0	96/6
1936-37 ..	396	222	175	1·3	103/2
1937-38 ..	430	233	196	1·2	119/–
1938-39 ..	456	225	230	1·0	112/2
1939-40 ..	474	211	262	0·8	109/9‡
1940-41 .	432	236	195	1·2	109/9‡
1941-42 ..	375	244x	129	1·9	109/9‡
1942-43	384	260xm	120	2·2	114/3‡
1943-44 ..	350	241xm	106	2·3	114/3‡
1944-45	318	206xm	99	2·1	147/9‡
1945-46	337	195xm	145	1·3	147/9‡
1946-47 ..	321	190m	129	1·5	173/6‡

* Calendar years 1925, 1926, 1927.
† Paterson marketing scheme operated from 1st January 1926.
o Paterson marketing scheme superseded by a compulsory plan in May 1934.
‡ British Ministry of Food f.o.b. contract price.
m Rationed from June 1943, at the rate of 8 oz. per head per week and reduced in June 1944 to 6 oz. per head per week, at which level it still remains.
x Includes consumption by Armed Forces in Australia.

Computed from *Commonwealth Year Books*, *Annual Reports of the Australian Dairy Produce Board*, and *A Summary of the Dairying Industry in Australia*, Vols. 8 and 11 (Mimeographed publication, Commonwealth Bureau of Census and Statistics, Canberra).

Factory managers realized that, under this scheme, it was less profitable to sell locally unless the local price was overseas price (less freight, etc.), plus the bounty from the pool; naturally, therefore, the local price rose above overseas parity price by the amount of the bounty. Under this scheme the few factory owners who did not adhere to the plan in principle or practice were able to make large profits by selling the whole of their output on the local market. In order to avoid this anomaly, a Commonwealth equalization scheme, with compulsory powers, was set up in the main dairying states in 1934. The scheme involved the fixation of 166/10 per cwt. for butter on the local market, irrespective of the fluctuations on the London market. In

1936 this procedure was, however, held to be invalid under Section 92 of the Constitution of the Commonwealth. By this time the industry had become used to the principle of obtaining special support from the local market, and as the price of butter in London was still low, the leaders of the industry made a special effort to secure adherence to the price equalization principle on a voluntary basis, and were successful in doing so.

The preceding table shows that the ratio of 'locally-consumed' to 'exported' butter decreased from 1926/27 till 1934/35, with a corresponding increase in the strain on the bounty provided by the local market. It is one story to support the export of a surplus when that surplus is half the volume of the local consumption; it is quite another to continue that support when the export is greater than that consumed locally. However, the price-stabilization mechanisms were a definite factor in expanding the industry during the decade 1930-40, although the devaluation of the Australian pound, together with the gradual improvement in efficiency, probably had as great an effect.

The onset of World War II brought many new complications to the industry. The British government agreed to purchase the exportable surplus of the industry at satisfactory prices. At first there was difficulty in obtaining refrigerated shipping space, and more storage facilities had to be provided. Later the industry was asked to divert more of its raw material to cheese and processed milk. Meantime, intensive recruiting campaigns were carried on in all country areas and the dairy farmer, always notorious as an unsatisfactory employer, began to find it most difficult to find milkers. The high wages offered for labour in the new munition factories in the cities stimulated some of those who had been struggling to earn a living on small dairy farms to sell out.

Faced with this threat of a decline in a vital industry, the Commonwealth government brought the wages of milkers on dairy farms under the Arbitration Court and agreed to subsidize the industry to enable it to pay them and meet its increased costs. The sums granted were:[10]

Year ended June	£000's[11]
1943 . ..	1,186
1944 .. .	7,346
1945 ..	6,812
1946	6,374
1947	5,223

10. Source: *A Summary of the Dairying Industry in Australia,* year ended June 1947 (mimeographed publication, Commonwealth Bureau of Census and Statistics, Canberra).

11. These amounts include assistance on export dairy products paid in the first instance by the Commonwealth government and recovered from the government of the United Kingdom. The actual amount recovered by 1 October 1947 amounted to £5,114,021.

The British government subsequently paid the part of these sums which referred to products exported to Britain. Meantime, the retail price of butter on the Australian market was kept at the pre-war figure, thus avoiding its political influence on the cost of living.

In addition to the above sums the Commonwealth subsidized whole milk consumption according to the following table:[10]

Year ended June	£000's
1944 .	319
1945 .	1,776
1946 ..	2,520
1947 . .	2,249

7. MINOR FORMS OF DAIRY PRODUCTION

Although milk and butter have always been the forms in which the bulk of the Australian dairy output has been sold, other products have not been neglected. Numerous cheese factories occur in various localities. The high temperatures of the summer months render cheese making and maturing a matter of some difficulty unless special precautions are taken. Australian cheese, in general, shows considerable variation in quality. The Australian public lacks what might be described as a cheese sense, and is usually not prepared to pay for the extra cost involved in maturing the product. The annual per capita consumption is remarkably low (4 04 lb. in 1937-39). Possibly this is explicable on the ground that meat and cheese are to some extent alternative foodstuffs, and meat is relatively cheap, although possibly of less dietetic value. During the war period meat was rationed and consumption rose to 6·0 lb. per capita.

The following table shows the Australian production and utilization of whole milk in million gallons.

	Quantity of Whole Milk used for—				
	Butter	Cheese	Condensary Products	Direct Consumption and other purposes	Total
1938-39 ..	925	65	33	166	1,189
1939-40 .	983	68	37	166	1,254
1940-41 ..	905	59	50	176	1,190
1941-42 ..	793	67	63	182	1,105
1942-43 ..	795	79	55	200	1,129
1943-44 ..	734	78	63	192	1,067
1944-45 ..	670	77	62	204	1,013
1945-46 ..	702	90	65	221	1,078

Source: *A Summary of the Dairying Industry of Australia*, Vol. 10 (mimeographed publication, Commonwealth Bureau of Census and Statistics, Canberra).

Condensed and dried milks have been made in various forms for many years. Dried skim milk, casein, and lactose are also produced by some factories, and at times these side lines assist them to increase the return to their farmer suppliers. During World War II the annual production of various kinds of preserved milks reached 78,000 tons.

CHAPTER IX

THE MEAT INDUSTRY

1. Beef
2. Mutton and Lamb
3. The Pig Industries
4. The Meat Industries and World Trade

mainly sold for bulk contracts to institutions and for those classes of the meat trade where low price is the main consideration. Owing to these circumstances, and despite the subsidies paid by the Commonwealth government, the industry was unable to make much headway at the prices which prevailed from 1920 onwards.

Technical improvements in cold storage and research into the reasons for the failure of chilled carcases to arrive in good condition eventually overcame the earlier difficulties, and, in 1934, regular shipment of chilled beef from Australia to the United Kingdom began (see table below). Competition was now on a uniform basis, as far as treatment is concerned, the small extra charge for the longer sea voyage being relatively unimportant. Henceforth success should depend on whether the Australian cattle man can produce and finish as cheaply as his competitors a carcase of the type required by world markets, and on his capacity to maintain an even supply to those markets so as to be able to establish steady trade connections, and thus avoid being continually in the hands of middlemen of the speculative type. Failing an ability to achieve these results, success had to depend on obtaining sufficient concessions through trade agreements to offset his failure in respect either to quality or price.

The Ottawa Agreements of 1932 gave a substantial measure of assistance to the Australian beef industry, as under it imports into Britain of various types of meat from the different exporting countries were regulated by quotas. The quota for Argentine chilled beef reduced the import from that country. There was no quota on Australian chilled beef, because at the time of the agreements the process for conveying it in safety had not been perfected. There was, however, a limitation on other classes of meat.

That these agreements were a definite stimulus to the Australian meat exports to Britain is shown by the following table.

Australian Meat Exports to United Kingdom for Ottawa Agreement Year (1931-32), compared with Exports for Period 1935 to 1943

(In thousands of cwt.)

Year	Chilled Beef	Frozen Beef and Veal	Frozen Mutton and Lamb	Pork
1931-32	Nil	1,124	1,488	Nil
1935	228	1,468	1,784	147
1936	296	1,524	1,496	233
1937	452	1,948	1,883	234
1938	528	1,881	1,940	287
1939	430	1,952	1,657	315
1940	..	2,102	1,759	463
1941	..	996	1,701	631
1942	..	232	1,487	131
1943	..	95	1,855	13

Source: ***Commonwealth Year Book,*** No. 36.

For many years prior to 1931-32 Australian beef exports to destinations other than the United Kingdom were more than 40 per cent of the total, but have since declined to less than 8 per cent, so the result of Ottawa may be regarded as a diversion of the trade rather than an expansion. Exports of mutton, lamb, and pork to countries other than the United Kingdom amounted to about 2 per cent of the total shipped.

The importance of the United Kingdom as an importer of meat increased both absolutely and relatively during the inter-war period. The import policies of the importing countries, coupled with increases in local production, were the decisive influences on the volume of trade.

The following table shows the quantity of meat contributed by each state to the Commonwealth export, and emphasizes the predominance of Queensland as regards quantity of beef. The Northern Territory does not appear, since, for statistical purposes, the location of the port of shipment determines the state of origin. In the case of lamb and mutton, the centre of production is in the south, although Tasmanian exports are surprisingly small, probably owing to the fact that the Tasmanian Merino is a special type, not well suited to the task of producing fat lambs, and, until recently, satisfactory crossbred ewes were not common in the state.

Average Australian Meat Exports by States for the Two Years ended 30 June 1939

(Thousands of cwt.)

	Beef and Veal	Mutton and Lamb	Pig Meat
New South Wales	143	474	13
Victoria	150	940	111
Queensland	2,256	47	159
South Australia	4	154	6
Western Australia	138	92	9
Tasmania	—	9	4
Commonwealth	2,691	1,716	302

Computed from the *Annual Report of the Australian Meat Board,* 1938-39.

During World War II the problems of meat supplies changed markedly. In the early stages lack of shipping made extra cool storage space and additional canning capacity necessary. When the southward advance of the Japanese occurred and the American troops arrived a tremendous strain was placed on meat supplies, especially of beef and pig meat. The Wyndham and Karumba meatworks (Fig. 59) closed down and all animals raised in the Northern Territory had to leave via the Queensland routes, except those which were used directly by the forces in the northern parts of the continent, or those which could be moved via Broome. Meat supplied to the civilian

standardization in quality and size will continue as a disadvantage to Australia in the competition for regular customers. These reforms, conditioned as they must be by the circumstances of the industry described in the following pages, are not likely to be rapid.

Fig. 58 indicates the distribution of cattle, other than dairy cattle, in the various states. Because of conditions discussed in earlier sections, the main development of the industry occurs in the northern half of the continent, although the concentration of cattle per square mile is greater in many districts in other parts.

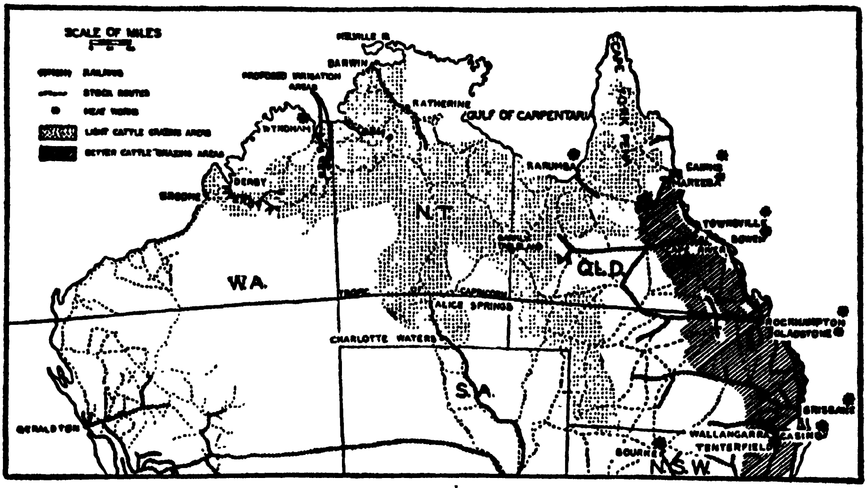


Fig. 59. The Beef Cattle Industry in Northern Australia

The areas where cattle-grazing is a major way of land utilization are indicated by hatching and dots, the dotted areas being generally less satisfactory than those which are hatched. Except in the eastern coastal areas along the Great Dividing Range, such distinction cannot be effective because in the inland areas cattle are frequently moved over long distances according to the available grazing, and their number is known only at time of mustering. Moreover, in these areas even if the number of cattle is known their grazing would be generally confined within seven miles of water-courses and water-holes (Fig. 34), hence differences in stocking rates are somewhat illusory.

The main lines of stock routes are shown except in Queensland where only a generalized plan is given, due to their great density. Stock routes which run along the railway lines are omitted for the sake of clearness.

Sources: Various reports on the pastoral industries of Western Australia, Northern Territory, Queensland, and personal knowledge of Messrs. W. A. Beattie and M. W. Mules, Animal Health Division, C.S.I.R.

Cattle Industry of the North

Fig. 59 shows a map of the principal cattle areas of the tropics, the location of the principal meat works, and chief routes along which the stock move. These areas are varied in character, the most important being:

(a) The Barkly Tableland,[2] a strip of 30,000 square miles, stretching from north-west Queensland into Northern Territory. This district has fair

2. *Report of the Board of Enquiry on the Land and Land Industries of the Northern Territory of Australia, 1937* (Govt. Printer, Canberra).

elevation, good underground water, and moderately good pasturage, but its centre is marshy and difficult of access in wet seasons.

(b) The Victoria River district,[2] to the west of the Northern Territory, is somewhat similar to the country of the Barkly Tableland.

(c) The areas between the Ord and Fitzroy Rivers, in the Kimberley district.[3] This is an eroded plateau region, of about 1,000 feet elevation, with

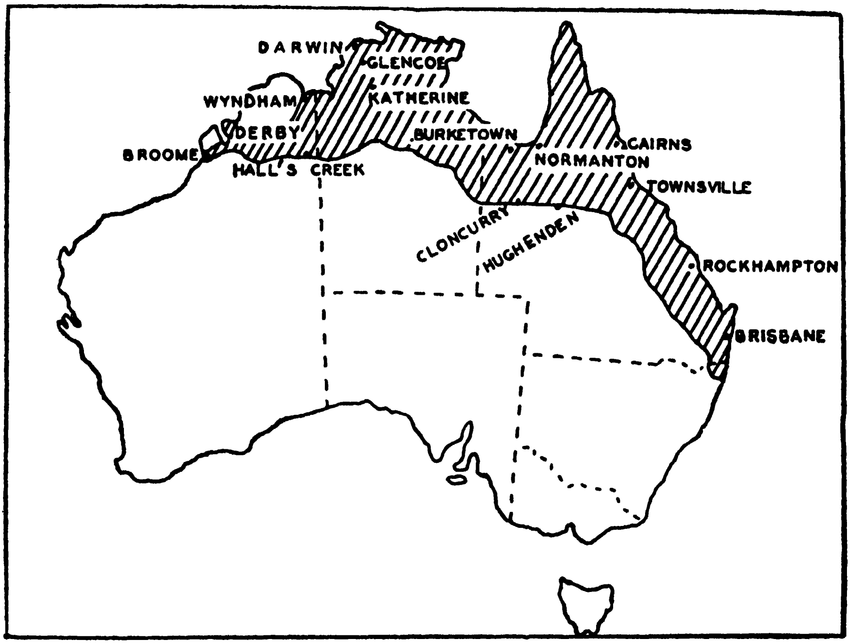


Fig. 60. Geographical Distribution of Cattle Tick

Infested areas are shaded

(Based on information kindly supplied by R. N. Wardle, Esq., Department of Health, Canberra; and by the Department of Agriculture and Stock, Queensland.)

occasional low mountains. Water is available for stock in the average season, but the soils are variable, and seldom rich (Plates 48, 49).

(d) In Queensland the coastal ranges lying to the east of the sheep country of the artesian basin enclose an area about 250 miles wide, having an annual rainfall of between twenty and thirty inches. This region stretches up through Cape York Peninsula; its soils are mostly poor, its forests light, and the terrain is generally too rough for sheep.[4]

3. *Report of the Royal Commission Appointed to Inquire Into and Report Upon the Financial and Economic Position of the Pastoral Industry in the Leasehold Areas in Western Australia, 1940* (Govt. Printer, Perth).

4. *Report of the Royal Commission on Abattoirs and Meatworks* (Queensland), 1945 (Govt. Printer, Brisbane); and *Annual Report of the Bureau of Investigation (Queensland) for the year 1946* (Govt. Printer, Brisbane).

ments of live cattle. The danger that it might come overland to the coastal dairying district of Queensland had long been realized. Fortunately, when this happened during World War II, DDT had been discovered and this new weapon seems likely to give control wherever the animals are frequently yarded. Pleuro-pneumonia is occasionally troublesome in the herds on the stations.[7] 'Carriers' convey the disease across country, and a systematic inspection of all herds passing into New South Wales is now in force. Recent researches into this disease have made it reasonable to hope that the near future will see its control more practicable in those areas where inspection and segregation are possible. It does not seem likely that control will be feasible for some time in the wide stretches of the cattle runs of the Australian tropics.

It was suggested that the introduction of blood from the Zebu species (*Bos indicus*) might, in many runs, go far towards overcoming the disabilities of the ordinary British beef breeds of cattle (*Bos taurus*) in the tropics as regards constitution, ability to live on poorer pastures, heat-regulating mechanism, and resistance to many ecto-parasites and diseases, particularly tick fever. Such procedure in similar country, e.g., Texas, has been found satisfactory under certain conditions. Accordingly, after many enquiries, a trial shipment of nine bulls and nine cows was selected and imported in 1933. They are being maintained and bred in six localities in Queensland, using them for cross-breeding with the cattle at present on the runs.[8] It is clear that great care and judgment are necessary in effecting this cross, and in eliminating unsatisfactory types which may be expected to appear among the hybrids. The principal difficulty lies in the wildness of these animals under range conditions.

The relative poverty of much of the herbage on which the herds graze during the 'dry' season, the liability of some of the districts to periodical droughts, and the need to keep the stock on the stations until such time as there is sufficient feed on the stock routes to enable them to reach railway or killing centres, raise the age at which the average beast is slaughtered, and in many cases it is more than five years old before it reaches the meat works (Plate 47). Animals of such an age are liable to yield tough meat whatever their breeding and are seldom worth chilling. More attention to watering facilities and to the policing and maintenance of adequate stock routes would effect some improvement.

Although prime young animals are normally produced from the more favoured areas, the difficulty in arranging for a steady production of such types under the conditions which at present prevail is considerable. While it is almost a *sine qua non* that cattle should be raised on the cheaper back

7. Turner, Dr. A. W., 'Studies on Contagious Pleuro-pneumonia of Cattle,' *C.S.I.R. Bulletin*, No. 93; and *C.S.I.R. Bulletin*, No. 97, by various authors on the same subject.

8. Kelly, Dr. R. B., 'Zebu Cattle in Northern Australia,' *C.S.I.R. Bulletin*, No. 172.

country, at first sight there does not seem to be any reason why they should not be finished in districts adjacent to the killing centres. The factors which have prevented the development of the industry along these lines are, however, fairly clear. In the first place, the coastal regions of higher and more reliable rainfall were originally heavily timbered, and the clearing was a task for individuals managing small areas. Further, the cost of clearing was, in most cases, too high for the land to be used for finishing cattle. Secondly, the dairy industry offered a medium of land utilization which was more suitable for pioneer farmers, because its returns per acre were higher and more regular. A third point is the fact that in the past the market has not been insistent on quality, and as long as the export took the form of frozen rather than chilled carcases, quality was of less importance. Finally, in the coastal areas of Queensland the cattle tick was a source of trouble. There are few localities in which pastures as good and as reliable as the finishing areas of the Argentine could be maintained with as little trouble. It may prove practicable to use irrigation areas in the north as special fattening areas for beef cattle. The Ord River project adjacent to Wyndham in the Kimberleys is at present under consideration and may lead to important developments.

At times criticism has been levelled against those operating some of the large runs on the grounds that they have done little to improve the properties, and that better results could have been achieved if more fencing and more water supplies had been installed. Doubtless there is some truth in this criticism, but, on the other hand, the price of fat stock before World War II was often no more than £3 per head on the stations, the cost of transport to the south being from £2 to £5 per beast. At such a price, little capital expenditure is warranted on country where carrying capacity is only of the order of ten beasts to the square mile. The investment of large sums on improvements in such ventures would have required much courage, especially in view of the inherent difficulties which have been mentioned in the preceding paragraph. Probably success could only be achieved by the management of combined properties under a central organization such as that which was evolved so effectively by the late Sir Sidney Kidman. The traditional political hostility towards large-scale enterprise culminating in the likelihood that leases would be periodically subdivided has been a further deterrent to investment.

Considerable attention has been drawn in recent years to the possibility of erecting killing works at inland centres. Although these proposals are superficially attractive it is not clear that these would be economic in view of their short season and the need for ancillary plants to deal with by-products.

The Cattle Industry of the South

To some extent the disabilities of the cattle industry in the southern half of the continent are of the same type, although less acute. The sources of

the special points necessary to establish complete confidence in the minds of buyers in overseas markets.[11] The difficulty lies in the fact that, if there were Grades A and B, and the local market preferred Grade B and the exporter Grade A, price movements for each grade would not always be in the same direction.

It is evident that there is the possibility of a great expansion in the export of lamb, provided that the export market can continue to return prices which will make it profitable for producers to extend the area of improved pastures. The export of mutton in increased amount is not so easily attainable owing to the reluctance of Britain to accept carcases showing signs of 'cheesy gland' (*Caseous lymphadenities*), a trouble which almost invariably results from bacterial infection after shearing. In any expansion the organization of the breeding along more definite lines, and attention to the special requirements of the export market, will be of great importance. To some extent the fluctuations in the volume of supply (Fig. 11), which are inevitable in a country with Australia's variable climate, are bound to be a handicap, but a wider use of irrigation areas for finishing livestock during recent years has made a considerable change which will increase as these areas improve (Plate 55).

3. THE PIG INDUSTRIES[12]

The relatively undeveloped condition of the pig industries in Australia has been the cause of much criticism of the farmers from time to time. It has been pointed out that skim milk, the by-product of butter-making, is a most efficient pig food, and that other dairy countries, such as Denmark, have built up a magnificent bacon and pork industry. What is not realized is that supplies of cereals and other concentrated foods are also necessary, and that other pig-producing countries are either able to grow the cereals readily or can obtain supplies of the necessary foodstuffs from many sources at low prices. In Australia, the dairy districts are, for the most part, removed from the cereal-growing areas, and there is a tendency for the cereal farmers to concentrate on production of high-priced grain, such as malting barley or wheat, or to rely on prices supported by a tariff, as in the case of maize. In addition, the large supplies of other kinds of meat at relatively low prices have prevented the development of a large home consumption of pork and its products.

However, during the early stages of World War II, when large stocks of wheat accumulated and the price was low, while pig meat was in demand at fair prices, a considerable number of wheat farmers, especially in Western

11. It has been stated that lamb buyers at Smithfield will purchase supplies from New Zealand agents by telephone on the grade alone, but the same men will not purchase Australian shipments without making an inspection.

12. For an analysis of the pig industry see E. Murray Pullar, 'A Statistical Survey of the Pig Industry in Australia,' *Aust. Vet. Jour.*, Vol. xxiii, 1947, and Vol. xxiv, 1948.

(*Victorian Railways*)

Plate 42. Irrigated dairy pasture, Tongala, Vic.

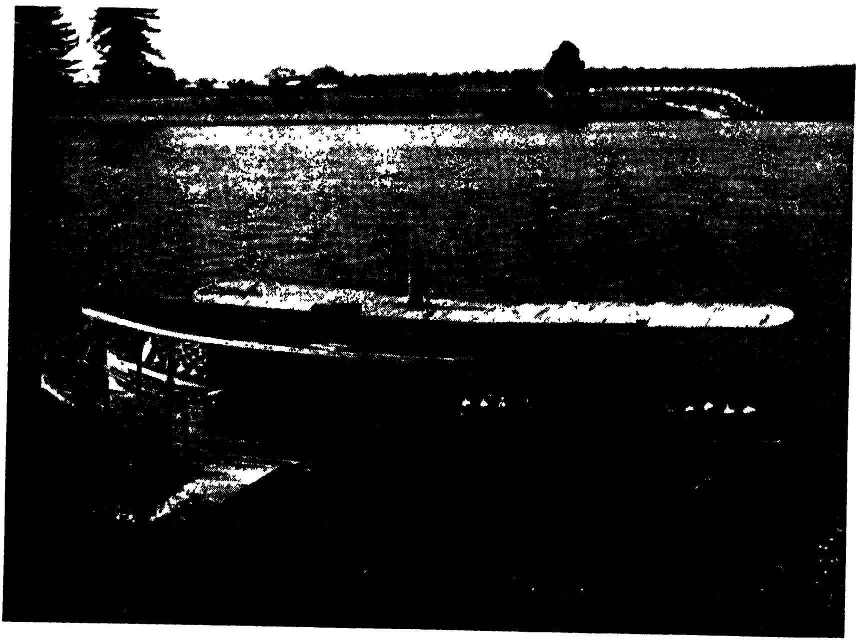
Note the distributing ditches and the relatively small paddocks.

(*Dept. of Agriculture, Vic.*)

Plate 43. Jersey dairy cattle; pasture with Red Gums, Dederang, Vic.

(R. P. Roberts)

Plate 44. Group settlement farm near Busselton, W.A.



(S.M.W.)

Plate 45. Cream collection by boat, Kempsey, N.S.W.

(*L. R. Scharp*)

Plate 46. Co-operative dairy factory, Maffra, Vic.

(C.S.I.R.)

Plate 51. Eucalyptus parkland and kangaroo grass, Flora River alluvial flat (170 miles S.E. of Darwin), N.T.

(*C.S.I.R.*)

Plate 52. Coolibah (E. microtheca), Acacia Bidwillii, *and* Dichanthium *savannah on Daly River alluvial flat, N.T.*

(C.S.I.R.)

Plate 53. Crest of a ridge with skeletal soil. Deciduous open forest, N.T.

(C.S.I.R.)

Plate 54. Open forest on gentle dip slope. E. phoenica *dominant, N.T.*

Australia, began to grow pigs on a commercial scale. With the great increase in cereal prices and the shortage of wheat which developed at the end of the war, this enterprise assumed a different aspect. Its future is uncertain, but obviously will depend on the relative prices of grain and pig meat and on the relative costs of shipping the two products overseas.

Pig raising and fattening require expert knowledge in a number of directions, especially in connection with nutrition. Such knowledge is comparatively rare in Australia, where, owing to 'extensive' exploitation of the land, the tendency has been to rely on the bounty of nature as expressed by pasture growth alone. Consequently, pigs have remained very much of a side line on many farms, and have not returned that amount of profit which might have been expected.

Despite the efforts of departmental officers to induce farmers to adopt standard procedures, there has been some conflict of opinion as to the most appropriate breeds. The reason for this is probably to be found in the fact that while one breed may be the most effective from the point of view of both market and producers if it is fed correctly, a second less desirable type may be more suitable under rough conditions. The adoption of the former breed, on the assumption that due care would be taken, might not always give satisfactory results if the feeding were badly arranged.

As matters stand today, a larger export trade is possible, but the quality of the produce raised is very variable, both in respect to configuration and character of the meat and fat. Further, the pig carcase is very susceptible to faulty handling during transit, and in the period immediately prior to slaughter. A better organization of the industry, so as to avoid troubles which arise during this stage, seems essential if a uniformly high-grade product is to be achieved. There can be no question that, if markets for pig meats can be extended, the capacity for pig production can be greatly increased. In areas where rainfall is adequate and well distributed, and soils are medium or light in character, its development would fit in well with a type of mixed farming in which dairying, pasture management, and some cropping were combined. Such systems of farming already occur here and there, but, under a more intensive scheme of land utilization, they would be much more frequent than they are today. The other possibility is the further development of pig raising in the grain-producing areas. Success in these regions would depend on the relative prices of grain and pig meat.

4. THE MEAT INDUSTRIES AND WORLD TRADE

It would be foolish to consider the possibility of expanding meat production without taking into consideration the consumption in certain countries. The following table shows pre-World War II meat consumption at the retail level.[13]

13. Chiefly based on average annual consumption for the period 1935-38 or 1935-39.

	Meat Kilograms per head per year	Grams protein per day		
		Total Protein	Of Animal Origin	Of Vegetable Origin
U.S.A.	88	88	50	38
Canada	79	87	47	40
United Kingdom	86	80	43	37
Germany	65	77	34	43
Denmark	77	76	44	32
Sweden	69	88	54	34
France	67	87	38	49
Italy	34	81	19	62
Spain	44	85	20	65
Greece	32	65	14	51
Turkey	20	101	26	75
Australia	134	90	59	31
New Zealand	128	96	61	35
India	8	56	9	47
Siam	56	58	21	37
Japan	33	67	12	55

Source: *World Food Survey*, published by the Food and Agriculture Organization of the United Nations, July 1946.

The significance of this table is to be found in the comparison of consumption per head in Britain and European countries. A rise in purchasing power and standards of nutrition in Europe would open up a completely new prospect for meat-exporting countries, particularly as more milk is likely to be a general requirement and therefore some areas in Britain and other countries will presumably have to transfer from cattle fattening to dairying. The position in Oriental countries is less definite and is complicated by trade restrictions and lack of widespread cool storage facilities; but considerable expansion of meat consumption is possible, provided the food habits of the peoples concerned are not so rigid as to make them unchangeable.

CHAPTER X

THE SUGAR INDUSTRY

1. Cane Sugar
    (a) Development up to 1914
    (b) Development after 1914
    (c) Conditions in the Industry
2. Beet Sugar

Chapter X

THE SUGAR INDUSTRY

1. CANE SUGAR

(a) Development up to 1914

THE first development of the sugar industry in Australia took place in the early 'sixties, on fertile river flats, in the northern coastal areas of New South Wales, and in similar districts in southern Queensland. By 1875 the annual productive area under cane had reached 11,000 acres. Fig. 13 shows the expansion in production since that time. In the more northerly districts the crop matures very much faster than in the southerly, so that in New South Wales it is usually a biennial.

The general line of expansion of the industry has been northward along the coastal belt, which varies in width according to the distance between the mountains and the sea, but is seldom more than fifty miles wide. This coastal zone consists of long tracts of infertile soil, bearing hardwood forest, between which are occasional patches of rich soil, originally covered by tropical rain forest or 'scrub', as it is locally termed.

These patches form the real sugar lands, on which heavy growths of cane can be produced provided the rainfall is adequate. The crop requires considerable amounts of water even in the dry season, and will not luxuriate if there are long dry periods. The Townsville district, with about forty-six inches in the year, has five months with little rain, and grows no sugar; under such conditions irrigation would be necessary for effective growth of the crops. In the Ayr district, with forty-one inches precipitation, irrigation is carried on by individual irrigators who pump water from the alluvial gravels of the Burdekin (Fig. 66), and the crop is grown. The map (Fig. 62) shows the location of the principal sugar areas, and indicates that they extend from the 30th parallel of latitude in New South Wales to the 17th parallel in Queensland. In the former state there has been no advance in the area under sugar since 1896. Since that time considerable areas which were once used for sugar-growing have passed into the hands of the dairying industry, which has made great strides in these particular districts.

In the early days the cane was mainly grown on fairly large estates, with the aid of 'indentured' black labour. In the negotiations which preceded the federation of the Australian states in 1901, the problems of national defence, and of ensuring a white population for the continent, assumed an important place. Sugar appeared to be the industry with the greatest capacity to settle white cultivators in tropical Australia. But the exclusive employment of white labour for hard manual work in the tropics seemed likely to raise

costs of production, and thus to threaten the economic security of a now important industry. So, although Queensland was prepared to agree to white labour in the common interest, she felt it necessary to stipulate, as a condition to her entry into federation, that a profitable Australian market be guaranteed for her sugar. Thus the Commonwealth government became the guardian

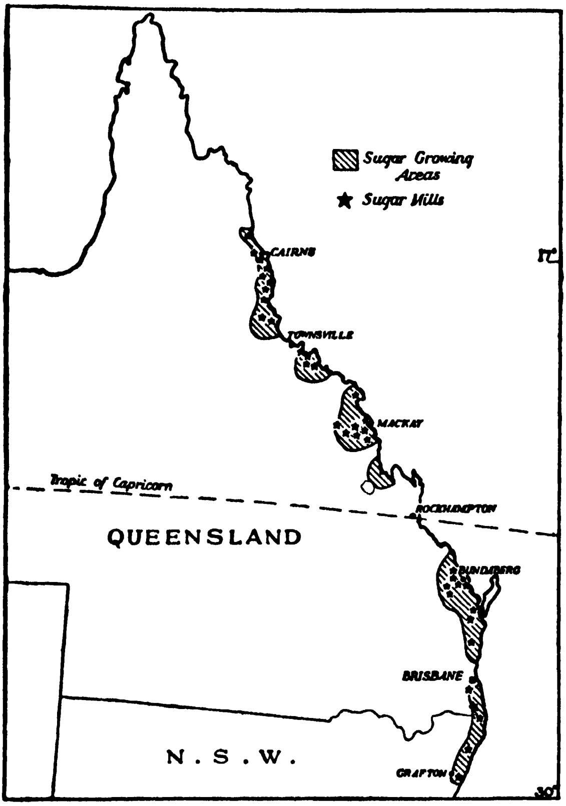


Fig. 62. Cane Sugar Areas of Australia

The map shows the areas in which cane sugar is grown, and the location of the sugar mills. It is to be understood that the areas indicated are not wholly occupied by sugar-growing, and contain many tracts of soil which would never be suitable for sugar cultivation.

of the industry, with all the disabilities that state regulation implies. The Kanakas were gradually repatriated, the movement being accelerated by preferential protection for growers employing white labour. The men rapidly became efficient, and the transition from black labour was complete by 1912. A duty on imported sugar, with several adjustments, maintained the industry —with little expansion in acreage—until the war in 1914. The amount of sugar produced remained at about half the national requirement, involving importations from overseas.

(b) Development after 1914

The first war period saw numerous changes. In the interests of consumers, the Commonwealth government took complete control of sugar in Australia (as well as certain other commodities). In 1915, an embargo was placed on exports, imports were controlled, and the Australian production was bought at a fixed price. The difference between production and consumption was met by imports from overseas under government contract, and the retail price was fixed. In 1915 the Australian price was £18 per ton of raw sugar produced. This was increased to £21 per ton in 1917. Meanwhile, as a result of the war, and the elimination of some of the normal sources of supply, a world sugar shortage had developed, and overseas prices soared. In accordance with the general increase in wage and price levels, the guaranteed Australian sugar price was raised, and finally reached £30.6.8 per ton of raw sugar in 1920. At this time the Commonwealth government was paying up to £80 per ton for its sugar imports, and was forced to raise the retail price to 6d. per lb.

Under these arrangements, the spread of the industry was rapid, and by 1921 the Commonwealth was virtually self-supporting in this commodity. In 1923 the Commonwealth handed over control of the industry to the Queensland government. An agreement between the two governments provided for the prohibition of imports of sugar, and the maintenance of agreed prices on the Australian market. It was also agreed that losses from exporting sugar at low prices should not be taken as a reason for increasing home consumption prices. The agreement with the growers has been renewed from time to time, and the present price of raw sugar entails a retail price of 4d. per lb. for refined sugar in the capital cities of the Commonwealth.

The following table shows the percentage of exportable surplus and the prices of 'home consumption' and 'surplus' sugar, and the average price in each year from 1936 to 1943.

Prices of Raw Sugar per Ton

Year	% Surplus of Raw Sugar	Home Consumption			Surplus			Average		
		£	s.	d.	£	s.	d.	£	s.	d.
1936 ..	55·0	24	2	0	7	19	0	15	4	8
1937 . ..	55·3	24	0	0	8	6	0	15	6	5
1938 .	56·3	24	0	0	8	4	3	15	2	3
1939 .	59·6	23	12	6	10	7	6	15	14	7
1940 ..	50·6	23	1	0	11	5	6	17	1	11
1941	40·3	22	13	0	10	18	6	17	18	7
1942	31·1	22	14	6	10	16	3	19	0	6
1943	15·4	22	10	6	13	2	6	21	1	6

Source: Tariff Board's *Report on Subsidy for the Raw Sugar Producing Industry*; Melbourne, 1944. (Mimeographed publication.)

The right-hand end of the graph in Fig. 13 is indicative of the rate of expansion of the industry subsequent to the adoption of the principle of a fixed price. Obviously this rate could not continue indefinitely past the point where production exceeded local consumption and exports were necessary. The considerable losses sustained on the export of sugar during the economic depression of 1930-34, when the world price fell to £5 sterling per ton, made it necessary to check further expansion. A limitation was imposed on the acreage cropped, through a system under which the specific area on each property which may be used for cane growing is designated. The mills could refuse to accept cane from plantation acreages not duly registered and approved, and in any case such cane was paid for at the export price only. This scheme has, naturally, turned the attention of growers towards the development of more scientific methods, so as to increase yield, and improvement in this respect was notable. The next step was the 'Peak Year Scheme'. Under the 'Peak Year Scheme' as modified in 1939, each cane-grower is 'assigned' an area of land. He may produce sugar cane from other land, but is entitled to receive therefor payment based on only 10s. per ton of raw sugar. He may, however, sell his cane only to the mill to which his land is assigned and is entitled to receive full price only for his 'farm peak' tonnage, that is, his proportion of the mill's 'peak' tonnage.

During World War II conditions were very difficult owing to labour shortages, lack of fertilizers, and of coastal shipping to move the raw sugar to refineries. Yields declined, but the average return to growers improved because a higher proportion was sold on the local market.

(c) Conditions in the Industry

Nowadays the greater proportion of the cane is grown on relatively small holdings, and fairly intensive methods are in vogue. The average area of cane per farm in Queensland was forty-four acres in 1936. A Bureau of Sugar Experiment Stations has been set up; this organization maintains research stations in the various sugar districts. Local committees take a large part in the scheme. Attention is being paid to the types of cane grown, to insect and other pests which are very troublesome in places, to manuring, and to general methods of cultivation. Production per acre increased fairly steadily up till the war period, as shown in the table on p. 227.

The work of cutting the cane and loading it for transport to the local mill is undertaken by gangs, which move about from plantation to plantation (Plates 56, 57). The work is arduous in the humid conditions which prevail, and wage rates are high. In 1938, cane-cutters in the Northern District were being paid from 8s. 4½d. to 16s. 11d. per ton according to the density of the crop and the district, and a man can cut several tons per day, thus earning high wages, though only for four or five months of the year.

Queensland Sugar Production, 1926-1945

Year	Yields Per Acre		Tons Cane to 1 ton Sugar	Year	Yields Per Acre		Tons Cane to 1 ton Sugar
	Cane	Sugar			Cane	Sugar	
	Tons	Tons			Tons	Tons	
1926 . . .	15·45	2·06	7·52	1936 . . .	21·10	3·04	6·94
1927 . . .	17·45	2·38	7·32	1937 . . .	20·56	3·06	6·73
1928 . . .	17·32	2·41	7·18	1938 . . .	21·28	3·10	6·87
1929 . . .	16·67	2·41	6·91	1939 . . .	23·14	3·41	6·77
1930 . . .	15·89	2·33	6·83	1940 . . .	19·50	2·86	6·82
1931 . . .	17·29	2·49	6·94	1941 . . .	19·41	2·82	6·87
1932 . . .	17·30	2·51	6·90	1942 . . .	18·26	2·54	7·18
1933 . . .	20·46	2·80	7·31	1943 . . .	14·84	2·125	6·98
1934 . . .	19·56	2·80	6·97	1944 . . .	19·79	2·90	6·83
1935 . . .	18·47	2·67	6 92	1945 . . .	18·98	2·69	7·06
				1946 . . .	16·26	2·24	7·25

Source: *Annual Reports of the Bureau of Sugar Experiment Stations, Queensland,* 1936 and 1947.

It is somewhat surprising that mechanical cane-cutters and loaders have not made more progress. The cane is crushed at thirty-six mills (thirty-three in Queensland and three in New South Wales), and the crude sugar is sent to refineries, which are located principally in the capital cities. The fact that the cane must pass through the central collecting points at the mills makes the control of the industry a relatively simple matter.

The restrictions on expansion of area in the industry have two unfortunate results; first, they entail a system of monoculture which must in the long run lead to soil depletion or degradation; secondly, they have been followed by a considerable rise in the market value of sugar lands, provided they have a permit for the production of cane for crushing. To some extent, this inflation of land values was inevitable, but it appears to have been stimulated, at least in some districts, by the tendency of labourers of southern European origin to offer high prices for small areas, with the idea of ultimately becoming independent landowners. Apparently the attitude of mind behind this movement was that life offered two alternatives to these men: they could continue to work on wage rates, or, having saved a small sum, they could buy land at prices which were, to some extent, uneconomic, in the ultimate hope that by living carefully they would liquidate their mortgages and become self-supporting landowning growers.

The system of protection of the industry has at times received severe comment from the southern states which are not seriously concerned with sugar production. There is little doubt that, had the industry been left to rely on its own resources, it would have suffered a staggering blow during the depression, which would not only have hindered expansion, but would have resulted in a contraction. It is not certain that any Australian sugar district would have been able to compete with the world price of sugar during

depression years. Most other countries producing sugar from cane suffered severely during this period; and in some, serious social disturbances followed in the wake of the price collapse.

Actually sugar is, apart from the cereals and forages, the most important crop in Australia, and in Queensland it is the most important single industry. If the lands devoted to it went out of production, the only alternative commercial use for them would be for dairying, and today the dairy industry is receiving more assistance than sugar production.[1]

It is possible that some of these areas might be used to advantage in connection with the fattening of beef cattle, but it is doubtful whether sufficient is yet known of proper methods of pasture management to make such a project effective. It is certainly extremely doubtful if white labour could produce in quantity in these districts any other crop which would be better able to compete on the world's markets than sugar. After all, there is little fundamental difference between the sugar policies of Great Britain or Czechoslovakia or the United States, and that of Australia.

2. BEET SUGAR

Sugar beet has found a footing in the Gippsland district of Victoria, in regions adjacent to the Maffra Sugaı Beet Factory. Here it had been found, from experimental trials carried on over many years, that sugar beet could be grown, and in 1898 a company erected a factory at Maffra. The installation was capable of treating four hundred tons of beet a day. Results were not satisfactory, and the state Treasury, which had advanced £53,000 of the £75,000 put into the plant and buildings, took possession. The mill remained closed until 1910, when it was reopened under government control. For many years it had small profits, and occasional losses. In 1924 it was remodelled; and during the 'thirties it made appreciable progress, and the state has been more than recouped for its outlay on the factory.

The roots are grown under contract with the factory, the acreage allotted to each grower being limited so as to ensure that the factory will not be confronted with a larger crop than it can handle. Before World War II the price paid to growers was on a basis of 40s. per ton of roots, plus bonuses if the average sugar percentage for the season exceeds certain stated amounts. The beets are grown partly on rich river flats, and partly on farms watered by the Maffra-Sale Irrigation Scheme (Fig. 70). The average production of roots per acre varies between fifteen and sixteen tons, and the average sugar content is usually about fifteen per cent.

In the areas concerned the farmers are divided in their opinions about the value of sugar beet. Some see in it a cash crop of a reliable nature; others

1. The retail price of sugar charged to the Australian public is at least fixed by a tribunal, in which the people's representatives play a part. At present the retail price of butter is fixed by a body which is not so controlled.

regard the heavy demands which it makes on the labour supply of the farm as a factor leading to the disorganization of the management of the property as a whole. Sugar beet production, in conjunction with dairying, on Australian farms where the labour force employed is usually small, is rather a different affair from sugar beet production in countries such as England, where it is only one of many crops, all of which are produced on the intensive plan with the expenditure of large quantities of labour. In both cases casual labour is employed at certain stages, but the English farmer is used to handling this class of workman, while the Australian is not.

During World War II casual labour became even more difficult, and as the Maffra area was particularly suitable for vegetable crops required for canning for the Armed Forces, the supply of roots to the factory declined and it was closed in 1944/45 and 1945/46. It re-opened in 1946/47 with a contract beet price of £3 per ton, at which figure losses seem likely to occur in the factory.

There is no question that the sugar beet industry could be expanded to a very considerable extent in many districts, provided factories were available to deal with the roots. On the other hand, it is clear that the Maffra factory would not have had such financial success had it not been for the assistance which it obtained by selling its product at the high rate permitted by the local protected market. Other beet factories would be unable to obtain this concession, which is not of serious moment to the cane sugar industry as long as production is only of the order of five thousand tons—the annual capacity of the Maffra factory.

Chapter XI

THE FRUIT INDUSTRIES

1. Apples and Pears
2. The Wine Industry
3. Dried Fruits
4. Canned Fruits
5. Citrus Fruits
6. Tropical Fruits

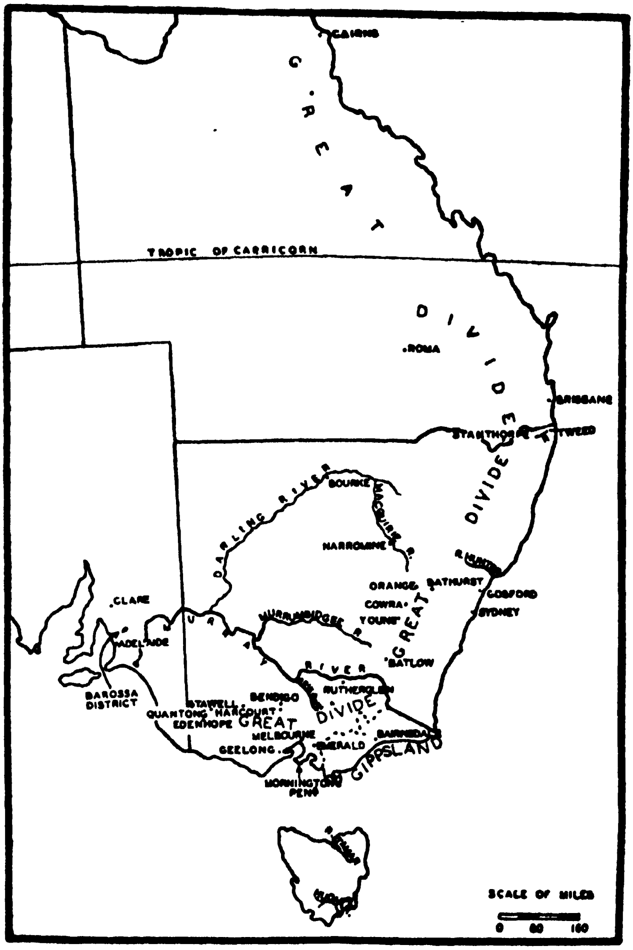


Fig. 63. Key map to geographical names mentioned hereunder which are not referred to on maps in following chapters

Chapter XI

THE FRUIT INDUSTRIES

THE area of the continent, and its distribution through the tropical and temperate zones, make it possible to grow in Australia almost any kind of fruit. The coastal belt of Queensland will produce such tropical types as pineapples, bananas, pawpaws, custard apples, and mangoes. Under irrigation the dry, hot areas behind the coastal ranges produce oranges and grapes, pears, peaches and apricots, while in the tablelands of the coastal ranges and in the southern states the fruits of cooler temperate regions—apples, pears, peaches, apricots, plums, figs and the berry fruits—grow under the natural conditions of rainfall. The relative absence of frosts during the period of blossoming is the main climatic factor which favours the industry, and for apples the fairly dry weather which is usual prior to and during the picking season has a beneficial effect on the keeping quality of the fruit. Nuts are not grown extensively, but have been cultivated successfully in a few places. Apple growing was the first fruit industry to expand on a scale sufficient to enter export markets. The production of dried and canning fruits was greatly increased during and after World War I. Banana growing was stimulated by a tariff on importations from Fiji, while more recently pear production, especially in Victoria, has been increased as a result of successful export overseas following research into the best methods of handling this fruit under cold storage.

1. APPLES AND PEARS

Production

The last decade has seen a considerable reduction in the acreage of apples in most of the states, but pear orchards have increased. The following tables set out the data.

Apple and Pear Acreage
(In thousands of acres)

	Apple		Pear	
	1935/36	1944/45	1935/36	1944/45
New South Wales ..	16·7	14·2	3·7	3·7
Victoria	30·5	21·7	11·3	13·1
Queensland	5·5	5·1	·2	·4
South Australia . ..	10·4	8·0	1·8	1·7
Western Australia ..	12·8	12·5	1·0	1·0
Tasmania	26·2	22·4	2·2	2·5
Total	102·1	83·9	20·2	22·4

Source: *Production Bulletins* (Commonwealth Bureau of Census and Statistics, Canberra).

The reasons for these trends will emerge from the economic story of the industry discussed later in this chapter.

Apple and Pear Production

(In thousands of bushels)
(A case = one bushsel for apples)
Average for the five-year period 1934/35-1938/39

	Apple	Pear
New South Wales	1,159	385
Victoria	2,281	1,381
Queensland	260	22
South Australia	933	224
Western Australia	1,247	114
Tasmania	4,602	270
Total	10,482	2,396

Computed from *Commonwealth Year Books* and *Production Bulletins*.

The figures of the above table must be accepted with some reserve, as wartime experience showed that in the period referred to the Tasmanian production recorded by the Statist did not include a considerable volume of fruit which was not picked. The totals of production shown above were usually sufficient to supply the Australian market and to provide the apple exports shown in Fig. 12.

Yields per tree vary widely from year to year and from district to district. In Tasmania on the many old-established orchards a crop of up to ten bushels of apples per tree is not unusual. In Victoria the average crop has increased with the grubbing of many unthrifty orchards, but from three to five bushels is expected in the better districts. In Western Australia yields are fairly good, but in some parts of New South Wales and in Queensland the crops are usually light. It follows that production costs are much higher in Queensland, but the growers in that state have the advantage of two months at the opening of the season during which they have little or no competition. Lower transport and distribution costs to local markets tend to offset the higher production costs in the higher consuming eastern mainland states, but this does not apply to exported fruit.

Location

The main apple and pear areas in the various states are distributed as follows:

In Tasmania, along the valleys of the Huon and Tamar.

In Victoria, in the region of the east and south of Melbourne, spreading into western Gippsland and the Mornington Peninsula, also in various isolated

areas in the hills, especially near Harcourt where early varieties grow well; the irrigation district of the Goulburn Valley is a well estabished pear-growing centre, mainly for canning (Plate 58).

In New South Wales in isolated regions of the Tablelands, especially near Batlow, Bathurst and Orange.

In Western Australia in the hilly country near Bridgetown and around Mount Barker (Fig. 71), both in the south-west part of the state. In these districts conditions for fruit-growing are very favourable; the two most difficult pests to control—black spot (*Venturia inaequalis*) and codlin moth (*Cydia pomonella*)—are almost unknown. The voyage to England is about a week shorter than that from the eastern states; further, a splendid reputation for the soundness and quality of Western Australian fruit has been built up.

In South Australia the Adelaide Hills are the only area where climate is sufficiently cool in the summer for these fruits.

In Queensland the orchards occur at high altitude in granitic regions near Stanthorpe in the ranges near the New South Wales border. The soils are rather poor and yields relatively low.

Production Practices

The first apple trees planted in Australia were largely imported from England and were on seedling stocks liable to attack by woolly aphis (*Eriosoma lanigera*). Later it was found that trees on Northern Spy and Winter Majetin root-stocks were resistant to this pest. Since the latter part of the nineteenth century the nursery areas in Victoria at Emerald, Bairnsdale and at Somerville on the Mornington Peninsula have been the main source of apple trees, grown on vegetatively propagated aphis-resistant stocks, supplying not only Australia but also South Africa and South America. The last two countries, however, are now largely meeting their own requirements. During the last decade much research has been carried out on stocks of various kinds and a wider variety is now used, especially as the aphis is now kept in check by a parasitic wasp (*Aphelinus mali*).

The error of the old practice of establishing orchards on poor shallow soils is now generally recognized, the present tendency being to use freshly cleared land of reasonable fertility. After the clearing is done, considerable labour is needed to dig out the roots of the natural vegetation. This is necessary to protect the fruit trees against the fungus *Armillaria mellea* and the root borer (*Leptops squalida*). Digging is followed by fencing, provision of a shelter belt around the orchard, grading of soil and planting. In most districts insufficient attention is still given to methods of planting to minimize soil erosion. In districts without irrigation individual catchment dams are often built to provide water for dry summers. Several annual sprayings for pest control are necessary, mainly against codlin moth and black spot (with the exception of Western Australia), and also against fruit fly (*Ceratitis*

capitata) in Queensland and in parts of New South Wales. The control of codlin moth is being greatly simplified by the commercial use of DDT sprays.

Under peacetime conditions the aim of most growers in the exporting states (Tasmania, Victoria, Western Australia and, to a lesser extent, South Australia) was to pick fruit and pack for export according to the limited shipping space allotted; the remainder, which might be a large or small percentage of this crop, would be put on the local markets and into cool stores. Here it was kept until the grower fancied the market was reasonable; it was then repacked and sent to the city.

Cold Storage and Packing

To some extent the very large expansion of cool storage space which occurred after 1919 was a disadvantage. The amount of fruit available became too large and was a continuous depressant of the market price in some states. As a result the apple selling season was extended into the following late orange and the berry fruit season, and even into the succeeding harvest of stone fruits. This result may be satisfactory for some purposes, but it means serious loss to some growers who tend to hold their stored fruit too long in the hope of a rise in the market, and thus lose quality. It is probable, however, that the avoidance of glut prices in the early part of the season more than compensates for this. In recent years considerable work has been done to determine the right stage of maturity and the most desirable cold storage conditions for some types of fruit.[1] However, there is no unanimity amongst growers as to stage of ripeness necessary at the time of packing for a maximum storage life, and a large part of the apples picked for export is handled in the packing-sheds of individual growers. Inevitably this leads to a great variation in standards, and to an excessive number of brands on the market. The state Departments of Agriculture, which assume Federal functions in the examination of fruit for export, have gradually evolved methods of packing and standards of quality suitable for the export trade, and these have been incorporated as Australian standards in regulations under the Commerce Act 1905-33 and the Customs Act 1901-36 by the Federal government. In 1934, a new system of grading the apples by colour was introduced, and a further elimination of undesirable varieties was made. The inspection, however, was still left actually in the hands of the states, and, until 1936, no genuine attempt was made to co-ordinate the views of the inspectors from various states. Progress from that date up to the war period was more rapid.

Larger packing-sheds are now more frequent, but there is still some way to go before complete efficiency is achieved. It would be possible to reduce to a minimum the number of brands going on to the market, and to

1. Trout, S. A., Tindale, G. B., Huelin, F. E., 'Investigations on the Storage of Jonathan Apples Grown in Victoria,' *C.S.I.R. Bulletin*, No. 135; and by the same authors: 'Investigations on the Storage, Ripening and Respiration of Pears,' *Jour. Dept. Agric., Vic.*, Vol. xxxvi, 1938, pp. 34-52, 90-104.

prepare definitely standardized packs, if each district were to pack exclusively in a district shed. The accuracy with which the specifications of contracts of sale could be met would be of great advantage to the Australian trade overseas.

Export Trade and Marketing

The development of the industry as described in chapter II, p. 33, was not controlled in any way, but was reasonably profitable until World War I. It is true that the fruit did not always arrive in sound condition, but for what arrived in a saleable state there was a fairly ready market. At that time no great quantity of fruit was available in England and Germany in spring and early summer, while the practice of cool storing European apples was rare. Consequently, there was a definite 'season' for the Australian fruit. Victoria followed the lead given by Tasmania, and was in turn followed by South Australia and Western Australia (Fig. 12).

World War I stopped the export trade for some years, but it was taken up again in 1920, under a price guaranteed by the Commonwealth government of £1 per case, c.i.f., London. In the years 1923, 1924 and 1925, prices in England were profitable, and a large expansion of exports took place. The general strike in England in 1926 played havoc with many Australian shipments, owing to the long delay between their removal from cool storage in the ships and their consumption by the public, and a fall in prices began.

By this time, too, American fruit held in cool storage and extremely attractively packed had begun to encroach on the Australian season; and, from 1928 onwards, with one or two exceptional years, the export of fruit was generally unprofitable to most of the Australian growers.

The year 1933 was one of crisis for orchardists. The Ottawa Agreement offered to Australia, as well as to other fruit-growing Dominions, a free entry for their fruit into the United Kingdom, while foreign countries were called upon to pay a tariff of 4s. 6d. sterling per hundredweight—about 1s. 7d. per box. There was a bountiful season in Australia, and, in the hope that the new tariffs would leave the market bare for Australian apples, over six million boxes were sent forward. The result was disastrous, and most Australian growers found that the sums realized for their fruit had not covered the cost of transport alone, while growing, packing and marketing charges had to be added to the loss. In succeeding years conditions were slightly better, but still persistently difficult.

Australia and New Zealand have the longest 'carry' to the markets of the world, and their position on the market has been retained only with difficulty. Western Australia probably grows the highest grade of apples, and has the best reputation on the markets; South Australia comes next of the Australian states, but has only a small volume for export. Victoria and

Tasmania have gone a long way towards correcting errors of earlier years and made strides in the packing and presentation of their fruit during the period 1935-39, but the increasing cost of improved packing and labelling has not been met by improved prices. New South Wales has entered the export business with a very good pack for the overseas markets. These states have been able to start their trading operations with the Granny Smith apple, one of the most reliable and most sought-after varieties in the world for general purposes. This Australian-raised apple is now being produced in many countries.

The following table shows the chief varieties exported in the years 1938 and 1939, and also the percentage of the total apple export represented by each of them.

	Variety	1938 Thousands of bushels	%	1939 Thousands of bushels	%
Tasmania	Stumer	930	19·4	972	16·1
	Cleopatra	314	6·6	247	5·2
	Jonathan	264	5·5	305	6·3
Western Australia ..	Granny Smith	119	2·5	229	4·8
	Dunns	28	·6	130	2·7
	Yates	34	·7	125	2·6
Victoria	Jonathan	254	5·3	94	2·0
	Yates	100	2·1	52	1·1
	Granny Smith	44	·9	34	·7
South Australia ..	Jonathan	160	3·3	42	·9
	Rome Beauty	77	1·6	76	1·6
	Granny Smith	9	·2	9	·2
New South Wales ..	Granny Smith	56	1·2	7	·1
	Jonathan	4	·1	2	—
	Cleopatra	1	—	—	—

Computed from *C.S.I.R. Pamphlet* No. 95, 'Australian Apples,' by Carne, W. M.

The export season from Australia cannot be prolonged for more than fourteen to sixteen weeks because handling costs and difficulties generally increase if the fruit has to be stored for long in Australia after harvest, and also because the market in England is well supplied by English, American and Canadian apples after the middle of August. The natural periods of supply to the British market are:

English fruit: August to November.

United States and Canadian fruit: October to February.

South African fruit: March.

Australian and New Zealand fruit: April to July.

Other markets are in Europe or in sea-port cities of Asia; but, although much has been said on the latter as a possibility, it is unlikely to be large until such time as cool storage space is available in the cities and the local population acquire greater purchasing power.

Marketing Organization

Behind this record of overseas markets lies a story of attempts to develop a market sense among the growers and to build up a co-ordinated policy with regard to the export trade. This is worthy of some detailed consideration as it typifies the difficulties of any attempt at organizing a very heterogeneous and widely scattered group of individualists. The haphazard development of the industry was the main cause of a lack of coherence among the growers. Indeed, few, if any, of the states could boast of an authoritative organization of orchardists. In 1927 the Federal government, having passed the necessary legislation, submitted a proposal to the growers for the formation of a Control Board, but the scheme was decisively rejected by the growers in every state except Western Australia.

In 1929, an organization was formed in Victoria, composed of both growers and shippers—or, to be precise, of both growers and the commercial firms responsible for making sales and all shipping arrangements. This organization—the first to recognize the need for commercial knowledge and experience among the growers—immediately showed some signs of success, and an exactly similar organization was set up in South Australia. Parallel, although not exactly similar, types of organization were formed or revived in New South Wales and Western Australia, while two separate organizations, the State Fruit Advisory Board and the Shippers' Committee, were in existence in Tasmania.

In 1931, these organizations were called together in Melbourne, and the Australian Apple and Pear Council was formed. This entirely voluntary organization has done much for the industry. After the disastrous season of 1933, the A.P.C. took steps towards a qualitative restriction of the fruit going to the European markets by limiting the number of ships available for taking the fruit. The number of exportable varieties was reduced to 41 (106 varieties had been shipped in one year), and further restrictions were placed on undesirable sizes.

In 1938, the Commonwealth Parliament passed an Act setting up a Board with statutory powers to control the export of apples and pears overseas. The Apple and Pear Board was to be composed of representatives of apple and pear growers from all states, and of representatives of shippers from the main exporting states: Tasmania, Victoria, South Australia and Western Australia, and was to commence to function in the 1940 season. Before the Board could operate, World War II began, and it was clear that export would be difficult if not impossible for some years. As the local market was

bound to be glutted if the whole crop were thrown on it, the Commonwealth endeavoured to save the industry by taking control of the whole crop and arranging for its disposal by a new Apple and Pear Marketing Board. This Board classified all apples according to varieties and states of origin, organized the supply of local markets, whatever export could be arranged and what was to be left in the orchards, growers being compensated for the latter. This suited the exporting growers fairly well, but was disastrous for those who were near the capital cities on the markets of which they sold most of their fruit. It was specially hard on those who produced specialty lines, and on those with very small orchards who normally acted as their own carriers. The marketing agents were also hostile because they saw in the new scheme the possibility of a continuing centralized system of selling. Protests were fairly vigorous in Queensland and in parts of Victoria, and after 1944 the scheme was dropped in all states except Tasmania, South Australia and Western Australia. Up to 30 June 1946, the apple and pear marketing plan cost the Federal government £4,220,215.

In 1947 the Commonwealth announced its intention of proceeding further with a controlled export scheme similar to that of 1938, and this is now under discussion.

Past experience has shown very clearly that a return of free marketing may be disastrous when once the British market is fully supplied. How long it will take to reach this position is uncertain. It may be that the difficulties of international trade are such that the North American crop is no longer a serious factor. It is clear that a considerable reduction has occurred in the acreage of apples in most states, and this may give a lower total production. This decline has certainly occurred in the districts which have proved unsatisfactory, and many growers have learned in recent years that it is more profitable to have smaller acreages in high production rather than larger orchards in a low state of fertility. It would therefore be unwise to anticipate a reduction in gross yield proportionate to the decline in acreage. On the other hand, the possibility of keen competition from large plantings made during the preceding decade in South America must not be overlooked. Nothing is more certain than that opposition by the growers to a sound, co-ordinated plan for exports would be disastrous; but that does not mean that it will not occur.

The story of pear marketing is somewhat different. Here the growers were dealing with a crop which presented more difficulty under cool storage conditions, but it had the advantage that the most widely planted variety (the William Bon Chretien = Bartlett) was a first-class canning fruit. Originally the export of fresh fruit was small, but the canning industry caused a considerable increase in acreage, especially in the Goulburn Valley. Later, certain trading agencies, realizing that if the fruit were picked under appropriate conditions and then pre-cooled prior to shipping it was possible

for it to reach Britain in good order, began to stimulate an increase in production of varieties most suited to export. This proceeded steadily before the recent war, and there was no sign that the overseas market was saturated. The contrast between the evolution of this carefully organized selling system and the haphazard growth of apple export is marked. Naturally, however, there must be some limit to the extent of such a development when the market is fully supplied.

2. THE WINE INDUSTRY

The grape and vine industries include the production of wines, dried vine fruits, and table grapes which occur in numerous places in the southern parts of the continent. Wine production is older than the dried fruit industry; and, in districts where yields are low and quality of the product is the aim, it is the main product. In the irrigated dried fruit areas production of grapes per acre is higher though the quality is usually lower. Nevertheless, very considerable quantities of wine are now made from fruit grown under irrigation. In either types of district spoiled grapes are often used for the manufacture of fortifying spirit. Fresh grapes of many varieties are sold in some quantity during the appropriate season from many districts. Some have been exported from time to time; but the long period of cold storage, the tenderness of most varieties, and the necessity for very careful handling, has limited the trade to small dimensions. Hot-house grape production has not been attempted. The two main industries will be discussed in turn.

Wine Production

The wines produced in Australia fall into three main classes:

(i) The great bulk consists of sweet fortified wines of the Spanish and Portuguese types. They are produced in South Australia and along the Murray; in the Murrumbidgee Irrigation Area (Fig. 70), and in the Corowa district of New South Wales; in the Rutherglen district, and on the Murray irrigation areas in Victoria (Fig. 70); and in the Swan Valley district of Western Australia (Fig. 71).

(ii) A Burgundy type, but heavier in natural alcohol than the Burgundy wines of France. This wine is popular in Great Britain and has been exported for years.

(iii) Light wines, such as clarets and hocks, produced mainly in the Hunter River Valley of New South Wales and in various districts of Victoria, South Australia, and Western Australia, where climate and soils are suitable. Comparatively little has been done to extend the consumption of light, dry table wines in Australia, or to place these on overseas markets, and their production has declined.

Location

The acreage under vineyards (for all purposes) is shown in Fig. 64, while a description of the main wine production areas in the different states is:

In South Australia there are about 58,000 acres under vines, 15,000 acres of which are in the Adelaide plain and foothills district, a development

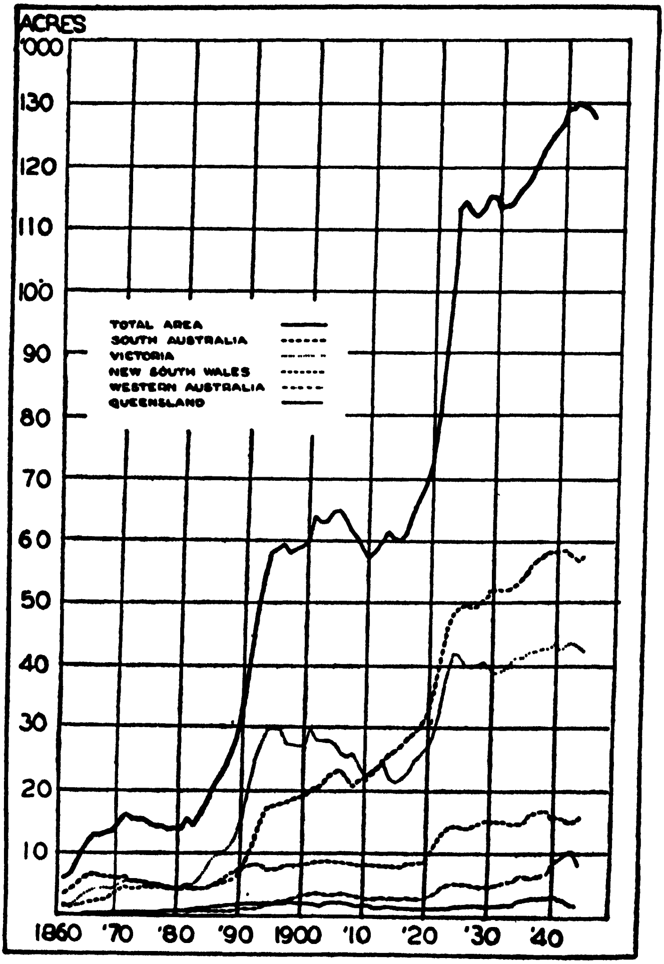


Fig. 64. Acreage under vineyards for all purposes

largely due to the initiative of German settlers. This area has long been noted for the production of wine, and the average production is about 5,000,000 gallons annually. The soils vary from medium to heavy clay-loams over clay and gravel subsoils. The Barossa district produces about 2,000,000 gallons

annually upon a wide variety of soils. The rainfall in these areas ranges from twenty to thirty-five inches, and soil and climatic conditions produce grapes rich in sugar and suited to the manufacture of full-bodied wines (Plate 59).

In New South Wales the most extensive area is in the Murrumbidgee irrigation district. On sandy to clay loams it produces mainly vines of Shiraz, Doradillo and Grenache types, from which about 1,500,000 gallons of wine are extracted. The Hunter Valley district is a non-irrigated area, specializing in the production of high quality dry wines. Yields, however, are very low compared with other areas in Australia, since hail, frost, flood and mildew are hindrances against which the industry finds it difficult to make headway. The soils are sandy, volcanic, and clay loams for the greater part. The other wine-producing areas in this state are comparatively small.

In Victoria the strictly wine-grape districts are now small, the chief being at Great Western, near Stawell, and at Rutherglen, in the north-east. They produce a variety of fruit, upon many types of soil, under differing climatic conditions. The irrigation districts have specialized in dried fruit production, but they now produce more fortified wine than the former areas. In the irrigation areas of the River Murray, large distilleries have been established, which process about 5,000,000 gallons of wine a year, drawn from about 800 growers. The industry was progressing well in this state until about 1890, when the ravages of the insect *Phylloxera* wiped out many of the vineyards in certain districts, especially those near Geelong, Bendigo, and Rutherglen. This pest attacked the root-stocks, and rehabilitation of the vineyards was only possible by complete replanting with resistant stocks. This procedure was never undertaken at Geelong or Bendigo, and the industry disappeared from those districts; at Rutherglen, however, the industry faced the problem, and a start was made on a new basis. The northern irrigation settlements on the Murray are planted with non-resistant stocks. To prevent the invasion of these areas by *Phylloxera*, the introduction of stocks from other districts is prohibited under heavy penalties. It is, however, a moot point whether the pest would flourish in the drier climate and the sandier soils of the Mildura district (Fig. 70).

In Western Australia the main vine-growing area is within a radius of twenty-five miles from Perth, and is situated on the slopes of the Darling Ranges and in the Swan Valley (Fig. 71). Soil conditions vary from deep alluvial loam in the valley to poor sandy loam on the hillsides. The industry is local, and, owing to the absence of export, is in a static condition, with wine-making as a small-scale industry, but capable of considerable expansion if markets were available and given technical direction.

In Queensland a small area of about 2,600 acres of vines is mainly centred in the highlands and at Roma, and most of these are concerned with table grapes.

Marketing

For twenty years after Federation the wine produced in Australia was only sufficient to supply the Australian demand, and to maintain an export to Great Britain of about 800,000 gallons, chiefly of heavier wines.

After 1920 a marked increase in production took place, owing to the planting of vines in areas prepared by state governments for soldier settlement. By the time the new vines had come into bearing it was evident that over-production of grapes suitable for fortified wine or spirit had occurred. In 1922 and the two following years the production of grapes was so large that the price of grapes dropped sharply, and something like a panic ensued in the vine districts. The Commonwealth government provided some relief from ruinous prices by the payment of subsidies to growers and by other measures. Production continued to increase until 1927, and many of the new growers had largely specialized in Doradillo vines, since these were hardy and prolific. The chief use of their fruit was for the distillation of spirit for fortifying sweet wines. Gradually the Doradillo vines were replaced by sultanas and other varieties used for drying. To help the growers, the Wine Export Bounty Act of 1930 was passed, fixing a bounty of 1s. 9d. per gallon on fortified wine exported, to be reduced in succeeding years.

At the Imperial Economic Conference at Ottawa, in 1932, the margin of preference granted by the British government was 2s. per gallon on Australian wines not exceeding 27 degrees of proof spirit. The bulk of the wine exported from Australia contains more than 27 degrees, and under the duties in force in the United Kingdom in 1932 Australian wines of a strength exceeding 27 but under 42 degrees received a preference of 4s. a gallon.

The following table shows the export trade in millions of gallons during the decade before World War II:

	Brandy in proof gallons	Sparkling wine	Still wine containing 27% of proof spirit or less	Still wine containing over 27% proof spirit
1930-31	—	2	402	1·802
1931-32	5	3	513	2·958
1932-33	15	1	413	2·681
1933-34	54	5	320	2·744
1934-35	86	4	339	3·050
1935-36	89	4	384	3·321
1936-37	135	3	300	3·785
1937-38	165	5	119	3·574
1938-39	115	2	332	3·385
1939-40	135	3	400	3·218

Source: *Oversea Trade Bulletins* (Commonwealth Bureau of Census and Statistics, Canberra).

After 1931 a recovery towards an annual output of eighteen million gallons of wine occurred, and, since most of the vineyards were in full bearing and little extension of plantings was made, production remained at about this figure, of which over a half was used for distillation to produce fortifying spirit.

At the onset of World War II, shipping troubles made it difficult for the industry to dispose of its produce, and representations were made to the Commonwealth government. Schemes of assistance were being worked out when the war extended to the Pacific region and large numbers of troops, many of which were of allied nations, were located in Australia. Beer production had been rationed, and the local consumption of wine not only eliminated any surplus, but led to the use of much wine before it was reasonably matured. This state of affairs continued beyond the end of the war, when large tonnages of grapes which had previously been used for drying were made into wine.

Meantime in Britain in war time the duties on all imported wines were increased, as the following table shows:

	Duty before World War II	Duty in 1945
Foreign Wines		
Not exceeding 25% proof spirit ..	4/-	17/-
" " 42% " "	8/-	34/-
Empire Wines		
Not exceeding 25% proof spirit .	2/-	15/-
" " 42% " "	4/-	30/-
British Wines	1/6	14/6

Source: 'Commercial Policy in Relation to Agriculture,' *10th Report of the Rural Reconstruction Commission* (Govt. Printer, Canberra).

The large preference in duties in favour of wines fermented in Britain makes the future of the Australian produce doubtful, although it is tolerably certain that there will always be some preference for imported wines by some sections of the population. Whether these sections will have enough purchasing power to absorb the Australian supply, and whether they will be satisfied with the quality of the Australian product, are questions which will be answered in process of time.

The main difficulties of the wine industry in Australia were summarized by R. H. Martin[2] in 1938, and they still hold good.

Since its inception, the industry has passed through long periods of depression, followed by long periods of great activity. When demand overtakes supply, planting immediately starts. In the rainfall areas, about five years would elapse before

2. *The Journal of The Australian Institute of Agricultural Science*, Vol. 4, 1938.

the result of the first planting would be felt. It then might be another five or ten years before the market began to become overloaded, and then there are five years of planting still to come into bearing and overload an already glutted market. In the irrigated areas, vines come into full bearing much more quickly.

In spite of the progress that has been made in the export trade in the last ten years, it certainly looks as if for the next few years production will be greater than market requirements. The trade with Great Britain has been developed with the assistance of Empire preference, the export bounty, and the depreciated Australian currency. The loss or adverse alteration of any of these would greatly affect the stability of the trade. Australia has her share of the New Zealand market, and is shipping wines to Canada, where there are distinct possibilities of increasing exports.

3. DRIED FRUITS

Dried Vine Fruits

Production

Sultanas (Sultana, Sultanina and Thomson's Seedless varieties) are the most important vine fruits, although lexias (Gordo Blancos) and currants (Zante) are produced in fair quantities. Fig. 15 in chapter II gives the total dried vine fruit production. The average production by states for 1940-44 is made up of:

	Currants (Thousands of tons)	Sultanas (Thousands of tons)	Lexias (Thousands of tons)
Victoria	8·7	40·5	5·4
South Australia . . .	9·1	12·7	3·8
New South Wales . .	1·3	7·2	0·6
Western Australia . .	2·7	0·4	0·1
Total . .	21·8	60·8	9·9

Computed from the *Annual Report of the Commonwealth Dried Fruits Control Board* for the year 1944-45 (Govt. Printer, Canberra).

Location

Today practically all the dried vine fruits are grown on the irrigation areas (Fig. 70), along the banks of the River Murray or its tributaries (e.g., the Murrumbidgee area, in New South Wales). In Western Australia the production is restricted to a small dry-farming area near Perth; a small area near Clare and Barossa in South Australia, and at Quantong and Edenhope in Victoria. At these places mainly currants are produced. In most of the dried vine fruit areas the topography of the land near the Murray River is such that the water must be pumped to supply channels at varying levels in order to serve the developed areas. The level to which the water has to be

pumped largely determines the relative costs of water at the various settlements, and the expense of pumping to high levels necessitates the irrigated land being used for such crops as vine fruits, stone fruits or citrus which show high returns per acre. In order to maintain the summer level of the river at a depth adequate for pumping purposes, and to preserve the stream as a navigable channel for several months of the year, an extensive system of locks and weirs has been built at considerable cost to the governments of the states concerned.

In the lower Murray basin, the outstanding features of the climate, apart from the low rainfall which is offset by the availability of irrigation water, are the hot dry period between November and March and the rarity of severe frosts. The first is of vital importance, because untimely rains during the ripening period sometimes cause considerable damage to the fruit, particularly to currants, since the sudden access of water causes the grapes to split, and also because the drying of grapes takes place in the open air. Severe frost damage occurs in the Murray River vine areas only about once in eight years. Minor spring frosts occur fairly frequently, but frost insurance premiums are too high to be of assistance to most growers. In the Mildura district frost protection has been improved through increased knowledge of the conditions under which frosts become serious. In bad spots the growers have formed frost clubs and, warned by alarm bells when the temperature falls below the safe limit, they then light up oil pots to decrease losses in the vineyards.

The soils on which vine fruits are grown show considerable variations, from deep grey sandy river loams of permeable nature, to Mallee sands which are also deep and with low clay percentage. However, soils of such composition are more frequently used for citrus growing. Fairly extensive areas of heavier soil also occur, e.g., Nyah and Merbein and Mildura (Fig. 70), where impervious clay layers appear in the profile at varying depths. On the latter types of soil the lavish application of water, which was the accepted method until a few years ago, has raised the water-table in many of the areas.[3] This frequently resulted in the accumulation of salt in the surface layers, and many vineyards were seriously affected. Citrus, and to a lesser extent most other fruit trees, are more rapidly affected by salt accumulation than the vines; and, on affected areas, there has been a considerable replacement of citrus or stone fruits by vines. The productive capacity even of vines,

3. The early abuse of applied water has left a legacy for fruit-growers in many districts, in the form of reduced productivity and high drainage costs. Much assistance on practical problems has been rendered to growers by the Viticultural Research Station at Merbein (Victoria). The Merbein Research Station began as an entirely local effort in 1917 with funds provided by a levy of 2s. 6d. per ton on all growers' fruit. Since 1927 it has been administered by the C.S.I.R. Detailed account of some of the investigations made are given in *C.S.I.R. Bulletin* No. 143, 'Production of Dried Grapes in Murray Valley Irrigation Settlements'—Part 1, 'Viticulture,' Lyon, A. V., Walters, D. V.; and Part II, 'Irrigation Drainage and Reclamation,' Lyon, A. V., Tisdall, A. L.

however, is decreased considerably by soil salinity. On several of the settlements extensive deep-drainage systems have been constructed, the cost being shared between the settlers and the state government. Yields of fruit have improved markedly as a result of this process.

Production Practices

The planting of an irrigated vineyard along the Murray valley calls for the expenditure of considerable amounts of capital, and about three years must elapse before the vines come into bearing. The actual cost of the various practices, such as clearing, ploughing, grading, planting, trellising, provision of drainage etc., varies considerably from block to block, apart from any differences attributable to the efficiency of management.

To illustrate the different types of work which are carried out in a dried fruit growing area, the Mildura district can be taken as an example. Here the pruning of vines begins towards the end of May after leaf fall, and is completed during the winter dormancy. During the late winter, the spring, and till harvest the vines are alternatively cultivated and irrigated about five times. In a survey carried out by McIntyre[4] in the Mildura district it was estimated that 63 per cent of the whole area is worked by tractor, either by the owner or by contractors. The irrigation water is allocated to each holding on a roster system. Other routine practices are the growing of leguminous crops for green manure in the autumn and winter months, and the sulphuring and spraying of vines for disease protection from bud-burst in the middle of September till harvest. Harvesting of currants usually starts about 1 February and is followed by the harvest of other vine fruits, most of which are off the vines before the end of March and dried by the middle of April (Plate 60). In districts which have a relatively cooler climate, such as Swan Hill, the harvest is about two weeks later than around Mildura.

In Australia, until 1925, the so-called hot dip method was used for the processing of sultanas. This treatment rendered the skin of the grape less resistant to evaporation, hence the shorter drying period resulted in a lighter colour of the product. From 1925 the boiling soda solution used in the hot dip method was replaced by a potash solution, which could be effectively used when cold. This cold dip made not only the work less unpleasant but also improved the colour of the sultanas, which after this treatment are light golden instead of brown. The hot dip is still used, however, particularly in the Nyah-Woorinen area (Fig. 70), often as a modified dip at about 180° F.

The fruit is mainly dried on racks which have six to eight superimposed tiers of wire netting on which they are spread. The removal of fruit when sufficiently dry is done by shaking each tier of the rack—the grapes fall through on to trays or hessian on the lowest tier. The fruit is 'finished off' on strips of hessian placed on the ground. It is then bulked and conveyed in

4. McIntyre, A. J., *Sunraysia—A Social Survey of a Dried Fruits Area* (M.U.P.).

'sweat boxes' to the packing-sheds, where it is graded. The stemmer and grader here replaces the bulk of the hand-picking as carried out in the Spanish factories, but some hand-sorting for colour grading is often practised.

Most of the dried vine fruits are produced from blocks owned and managed by one man. The amount of employed labour is generally small, except during the harvest period, when large numbers of casual labourers find employment in picking and processing the crop and carrying it to the packing-sheds.

The Packing-shed Position

Following on the pioneer phase, in which each grower packed his own fruit, there came a period of so-called co-operation, under which a central packing-shed was used for each settlement. These sheds were run by the growers themselves and were, theoretically, an economy in packing. Internal disagreement, however, led to the abuse of the system, and the numbers of packing-sheds became excessive. By 1927 there were sixty-seven in South Australia, handling approximately 12,000 tons of fruit. In Victoria, forty-four handled 41,500 tons.

Since that time the position has been steadily improved, and most of the inefficient and ill-equipped units have now been abandoned. The change has largely been brought about by the Federal government adopting recommendations made by the Development and Migration Commission in 1927.[5] All packing and processing sheds must now be registered annually, and, to retain this permit, they must conform to rigorous standards of building construction and general hygiene. The grading of fruit is also of a high standard, so that only uniform lines of fruit are marketed at home or abroad.

In 1946, there were twenty-six sheds in Victoria, packing a total of 48,000 tons of vine fruits, while the number of sheds in South Australia had been reduced to thirty-five, packing a crop of 13,300 tons.

Marketing

The period from Federation to the outbreak of war in 1914 was one of steady expansion (Fig. 15). Production of dried vine fruits had begun in New South Wales by 1908, and in Western Australia by 1913, although the areas concerned were comparatively small. In 1904, the growers' organizations in the producing states were amalgamated into the Australian Dried Fruits Association. This body controlled the marketing of the fruit of its members, and handled a very large proportion of the Australian production. By 1907, production had overtaken Australian consumption and the export trade commenced to expand. During the later years of World War I, when many important foreign areas were playing a less important

5. *Report on the Dried Fruit Industry of Australia* (Govt. Printer, Canberra).

part in world markets, prices rose to high levels and the industry entered a period of unprecedented prosperity.

After World War I there was an urgent need for settlement schemes whereby returned soldiers could commence a life on the land. In the opinion of the Federal government, an industry which suited the desired conditions was the growing of dried fruits. Only small holdings were required, prices for the products were high, and an adequate area of land was available for immediate development. Many irrigation settlements were commenced along the Murray, and the acreage under crop increased rapidly.

Then came the slump, which affected all vine-growers alike. The Australian Dried Fruits Association fixed both the percentage of the crop which had to be exported each year by members and the price at which the fruit could be sold on the Australian market. In 1923, the world markets price fell from £90 to £45 per ton. In 1925, preference on Empire markets was increased and the position of the industry was strengthened. Another price collapse occurred when foreign producers resumed export, and just as the new Australian areas came into production. This crisis had been foreseen by the A.D.F.A., which agitated for legislation to prevent growers outside the organization from selling the whole of their crop in the favoured home market. The condition of the industry was critical, and the necessary legislation was passed in each of the producing states in 1925. Dried Fruit Control Boards were set up under state acts, which determined and enforced quotas for the home markets. This, however, did not prevent interstate trading from upsetting the local market in any one state. Some Commonwealth control was obviously necessary; and, in 1928, at the request of the state governments, the Commonwealth Dried Fruits Act was passed, under which the Commonwealth Dried Fruits Control Board was set up to deal with currants, sultanas and lexias. For each state this body fixed quotas which had to be exported before fruit could be sold interstate.

During the economic depression after 1929 the production of dried vine fruits was probably the most stable rural activity in Australia. The repatriation schemes based on this industry had been relatively successful; but its stability was largely due to the protection given to the industry by fixing prices on the home market at a level somewhat higher than overseas parity, on the one hand, and by tariff preferences on Empire export markets, on the other. In addition, as already noted, methods of processing and packing were considerably improved. As a result, the product had reached a standard of quality and uniformity in respect to grading which enabled it to command the confidence of wholesale buyers, and to realize a higher price than would otherwise have been possible.

By a decision of the Privy Council in 1936, the Commonwealth Dried Fruits Act of 1928, which limited interstate trade in dried fruits, and

co-ordinated the marketing legislation in each state by preventing state quotas being exceeded by an influx of fruit from another state, was declared unconstitutional. This decision jeopardized the position of the industry, and the Federal government unsuccessfully appealed to the people for power to amend the Constitution. However, uniform legislation in producing states has since proved quite effective in controlling the industry in the absence of Commonwealth powers, and the existing marketing organization has been maintained. Interstate selling of processed fruit is not practised, because of the loyalty of the marketing organizations, while quarantine and other regulations within the states prevent the interstate transport of fresh fruit or the establishment of new sheds outside the organization. In other words, the industry has learned how to control itself.

The industry is fully alive to the fact that its success is partly due to Empire preference, which has given it considerable advantages over its competitors, not only in Britain but also in New Zealand and Canada, as the following table shows.

Average Export of Australian Dried Vine Fruits for the Seasons 1933/34–1937/38

Country to which consigned	Currants (Thousands of tons)	Sultanas (Thousands of tons)	Lexias (Thousands of tons)
United Kingdom	9·8	23·5	2·2
New Zealand	0·6	2·5	0·4
Canada	2·0	11·3	0·8
South Africa	0·2	—	—
Other Countries	0·3	0·4	—
Total	12·9	37·7	3·4

Computed from *Supplies of Canned and Dried Fruit*, 1938, Imperial Economic Committee publications, London, 1939.

If this system were abandoned, a considerable fall in prices might occur, unless world consumption of these fruits increased sufficiently to absorb the whole of the world crop, and unless steps were taken in all producing countries to correlate future planting with prospective demand. For some time past the leaders of the industry in Australia have urged that any policy of new planting should have regard to the world market situation, and more particularly to the position of the Australian industry in relation thereto.

Dried Tree Fruits

Dried tree fruits are also produced in small quantities in various districts where the climate is suitable or where irrigation makes high yields practicable, and in districts which are not too dry for the trees but dry enough for the

process of desiccation. The trend for some years has been towards artificial dehydration, and sun-drying is declining.

Production of Dried Tree Fruits, Australia
(Thousands of lb.)

Kind of Fruit	1938-39	1940-41	1941-42	1942-43	1943-44
Apples	762	1,855	2,596	4,030	5,316
Apricots	2,764	4,166	4,184	2,805	3,743
Figs	110	157	148	177	168
Peaches	1,017	1,257	894	871	1,064
Pears	809	652	672	699	757
Prunes	3,705	4,868	7,083	6,164	6,173
Nectarines	96	116	60	40	45
Other	78	121	76	38	83
Total	9,341	13,192	15,713	14,824	17,349

Source: *Production Bulletin*, No. 39 (Commonwealth Bureau of Census and Statistics, Canberra).

The marked increase in the production of dried apples during the war period was a special feature caused by wartime needs; it served as one means of preserving that part of the apple crop which was not needed for export and would otherwise have been wasted. Prune production has an interesting history. A large part of it occurs near Young in New South Wales, and for years there was difficulty in disposing of the crop. Later, greatly improved methods of processing and packing the fruit caused such an increase in demand that the problem of finding markets disappeared.

During World War II many dehydration plants were installed mainly for vegetable, as well as for fruit processing. This expansion will be discussed under vegetable crops in chapter XII.

4. CANNED FRUITS

This survey would be incomplete without some reference to preserved fruits. Factories have been established in the capital cities and in certain irrigation areas—notably in and near Shepparton, in the Goulburn Valley, and at Leeton and Griffith, on the Murrumbidgee (Fig. 70)—and at a few local centres in Queensland. The total pack of the four principal fruits—peaches, apricots, pears and pineapples normally amount to between two and three million cases.[6] In addition, considerable quantities of fruit pulp are exported, especially of berry fruits. Owing to the expansion of the domestic market, the export trade has declined slightly in the years preceding World War II. The figures for production and export are shown below.

6. A case is a commercial unit of 24 tins each containing 30 oz.

Five-yearly Averages of Canned Fruit Production
(Thousands of cases)

State	Apricots		Peaches		Pears		Pineapples	
	1935/36–1939/40	1940/41–1944/45	1935/36–1939/40	1940/41–1944/45	1935/36–1939/40	1940/41–1944/45	1935/36–1939/40	1940/41–1944/45
N.S.W.	88·8	58·6	197·4	152·8	31·0	24·4	—	—
Vic.	166·6	131·4	1060·8	985·2	625·0	150·4	—	—
S.A.	34·0	29·4	18·4	18·6	77·0	51·0	—	—
Tas.	23·6	10·8	—	—	52·2	35·0	—	—
W.A.	—	0·2	—	—	—	—	—	—
Qld.	—	—	—	—	—	—	317·2	237·4
Total ..	313·0	230·4	1276·6	1156·6	785·2	260 8	317·2	237·4

Computed from the *Annual Reports of the Australian Canned Fruits Board* for the years 1939-40 and 1945-46.

The southern section of the canned fruit industry (peaches, pears and apricots) has had a somewhat chequered career. It was expanded considerably after 1919, but soon found that its production and processing costs were out of line with world markets. Re-organization was effected by changes in the varieties grown, in orchard practices, in factory organization and capitalization and in marketing methods. Overseas marketing was placed by the Commonwealth government under the Australian Canned Fruits Board. The part played on the British market by Australian canned fruit before 1939 is indicated in the following table. The United States has been the largest supplier. Australia was, however, the principal Empire source of the main varieties of canned fruits, other than pineapples. During the last few years before World War II, Australian fruit has entered Canadian and New Zealand markets to an increasing extent because the industry has had the advantage of some preference under the Ottawa scheme.

Imports of Canned and Bottled Fruits into United Kingdom
(Thousands of cwt.)

Country where consigned	1930	1932	1934	1936	1937	1938
Australia ..	231	237	501	377	605	594
Malaya ..	608	891	851	903	900	858
U.S.A., incl. Hawaii ..	1,457	1,872	1,758	2,020	1,718	2,047
Other ..	134	203	342	423	436	499
Total ..	2,430	3,203	3,452	3,723	3,659	3,998

Computed from *Supplies of Canned and Dried Fruit,* Imperial Economic Committee publications, London, 1934, 1938.

The industry buys its sugar at a concessional rate which enables it to meet its overseas competitors on equal terms in this respect. The yields of fruit per acre are usually lower than in California, but this may be gradually rectified by more detailed knowledge of the soil requirements of the various types and varieties. The industry is reasonably efficient, but its main trouble lies in the fact that its export forms roughly half its total pack, and unless that export can be achieved at satisfactory prices it must be in a difficult position. By contrast, only about a quarter of the production in the United States is exported; and, in a glut year in that country, there may be a tendency to clear stocks at very low prices. The industry is capable of considerable expansion; but the economic risks of such a process will be considerable unless world trade can be expanded or an international marketing agreement can be developed.

The northern section which deals with pineapples, and to a minor extent with pawpaws, has to meet competition from Hawaii and Malaya, both countries of much larger production. The export has, therefore, been relatively small and has had to rely on the quality of its product.

5. CITRUS FRUITS

Various types of citrus fruits grow well in numerous districts of appropriate climate. Liability to frost, adequacy of rainfall, suitability of soil type and the presence or absence of insect pests are the main controlling factors. The largest area of oranges is in the coastal districts to the north of Sydney, where production has been prominent for many years. The advent of the Washington Navel orange and its suitability to the climate of the drier irrigation areas has been the dominant development of the present century (Plate 61).

Production

The acceleration of irrigation settlement in the period just after World War I caused a considerable expansion in citrus acreage. At that time the supply of oranges during the winter months was not equal to the local demand; imported fruit from California realized high prices, and stimulated Australian planting. Unfortunately, for some years, the rate of planting was too high, and insufficient care was taken in respect to the types of bud used. As a result, the new groves contained many unsatisfactory trees and a steady system of reworking has been necessary to remedy these defects. The rush after World War I to grow citrus fruits was also responsible for the planting of many acres on soils which were relatively unsuitable for these trees; consequently, although success has been outstanding on some soil types, on others the results have been more moderate, and in some definitely disastrous. Areas in which salt troubles, even of a minor type, occurred have proved quite unsuitable.

Area under Citrus Fruits in 1945

(Thousands of acres)

	Oranges	Mandarins	Lemons and Limes	Grape-fruit
N.S.W.	21·6	3·0	3·3	·7
Vic.	4·8	·1	1·3	·3
Q'land	1·8	·9	·2	—
S.A. .	4·6	·1	·3	·1
W.A. . .	3·3	·2	·5	·2
Total	36·1	4·3	5·6	1·3

Source: *Report on the Citrus Industry Survey, 1945.* Bureau of Agricultural Economics, Bulletin No. 1. (Commonwealth of Australia, Department of Commerce and Agriculture.)

Location

In New South Wales the old citrus area in the Parramatta district near Sydney produces mainly the 'common orange' variety and mandarins. The quality is not particularly good, and when the export trade to New Zealand, which was of special importance to this district, was stopped in 1934-45 a serious slump set in for these growers. The Gosford district, on the coastal area of New South Wales, produces some good quality navel oranges. Both these districts have the disadvantage of being subject to the Mediterranean fruit fly. The Murrumbidgee irrigation area (Fig. 70) is now growing a large acreage of navel types, which are improving steadily in quality and favour; but many of the groves are threatened by the high water-table which has developed. Other irrigation areas near the Murray, such as Curlwaa (Fig. 70) are somewhat similar. A few oranges are produced on the Macquarie River near Narromine and at Bourke on the Darling.

In Victoria, lemons grow well in southern districts, provided the soils are adequately manured. In the central irrigation areas, such as those of the Goulburn Valley, citrus growing has declined, but some good Valencia-type oranges are grown while navels, Valencias, and grape-fruit do well in the north of the Mildura-Red Cliffs irrigation district (Fig. 70), where temperatures are somewhat higher.

Along the Murray in South Australia there are some excellent groves on the irrigation areas, e.g., at Renmark (Fig. 70); these produce Washington Navels of outstanding quality. The fruit has a well-deserved reputation in Adelaide and Melbourne, while some export to New Zealand and London is carried on with success. This high standard is not universal through the state, but the quality is generally high.

Western Australia has developed citrus for its local market in recent years. The groves are situated on the coastal belt, within easy reach of Perth.

In Queensland, the citrus acreage is rather widely spread, but it lies chiefly in the coastal fringe and in the eastern mountain ranges, mainly in the south-east of the state.

Grape-fruit production is expanding in various states. There is still a good deal of variability in quality, but steady improvement has been noticeable during the last ten years. A section of the Australian public is gradually becoming appreciative of grape-fruit, and some expansion in consumption should take place. During the summer this fruit has sometimes been imported from California or Palestine.

Export Trade

The possibility of expanding the export trade has been freely discussed on many occasions, and the Commonwealth government decided to give a bounty on exported citrus during 1934-35. In reprisal for Australian action in refusing to accept the Dominion's potatoes, New Zealand placed a quarantine restriction on Australian citrus fruits. The largest export in any one year was 314,000 centals. Unfortunately, the prospect for the development of a large export in citrus fruits is poor. Under the conditions of cool storage, the Washington Navel becomes unreliable if kept in store for more than a month,[7] and South Africa is exporting to Britain at the same season. The Valencias, which give more satisfactory results from the storage point of view, are available for export later in the year, but there is no surplus—particularly those of good quality. The large development of acreage under oranges in Palestine and South Africa suggests that it would be unwise for Australia to expect to expand this trade. Grape-fruit export during the middle of the year is a possibility, but it will be necessary to ensure high quality, and South Africa is a major competitor.

The expansion of acreage under citrus after World War I suggests that an awkward situation, similar to that which developed for apples, might overtake the industry if expansion were stimulated on the grand scale. The higher volume of consumption, and the wider recognition of the nutritional value of citrus in the diet of children, have enlarged the local market. Numerous conferences were held in 1945-46 to consider the extent to which citrus plantings should be encouraged, and a moderate policy has resulted. The important point is to ensure that the new groves are located on the soil types where high yields and low cost of production may be expected.

6. TROPICAL FRUITS

Chief among these are bananas, pineapples and pawpaws. The distribution of acreage under these in 1944-45 is shown in the following table.

7. Huelin, F. E., 'The Handling and Storage of Australian Oranges, Mandarins, and Grape-fruit,' *C.S.I.R. Bulletin*, No. 154.

	New South Wales	Queensland	Western Australia
	Acres	Acres	Acres
Bananas . .	15,250	8,132	182
Pineapples .	229	7,004	—
Pawpaws	27	1,257	—

Source: *Commonwealth Production Bulletin*, No. 39.

Bananas were originally imported from Fiji, but the development of the Tweed River and some other coastal areas of New South Wales and Queensland gave transport facilities to many regions where the fruit could be grown readily. The protection of the tariff was, therefore, invoked; and the acreage expanded rapidly during the decade 1910-20, since a market was assured for the fruit. About 1922 many plantations in the Tweed district of New South Wales had become infested by the trouble known as 'bunchy top',[8] which was later demonstrated to be a virus disease, but only the more southerly of the Queensland districts were affected. The industry was almost extinguished in many centres in New South Wales and Queensland by 1927. Scientific enquiry devised means of checking the trouble, and a rigid scheme of control was instituted. This resulted in a return to production of the areas of New South Wales, and the industry has resumed on a more or less stable basis.[9]

The plantations are mainly placed on the hill slopes in the coastal areas of high rainfall of northern New South Wales and of Queensland as far north as Cairns. The soils are loamy and plantations are kept free from weeds. Unless terracing and contour planting are adopted, erosion is liable to become a menace. In the past the practice was exploitative; and since no attention was given to erosion and soil fertility, the plantations lasted less than ten years. Today little land with correct aspect, soil type and slope remains, and more intensive practices involving the use of fertilizers are coming into use.[10]

The fruit is sent to the markets of capital cities by an efficient rail service which would be improved under a system of unified gauge. More care is now being taken with the ripening process than heretofore, and the quality

8. Magee, C. J. P., 'Investigation on the Bunch Top Disease of the Banana,' *C.S.I.R. Bulletin*, No. 30.

9. Eastwood, H. W., 'Bunchy Top Disease of Bananas,' *Agr. Gaz. of N.S.W.*, Vol. 57, 1946.

10. A paper by Summerville, W. A. T., gives a full account of the banana plant: 'Studies on nutrition as qualified by development in *Musa Cavendishii* Lambert,' *Queensland Journal of Agricultural Science*, Vol. 1, 1944.

has shown some improvement in recent years.[11] Fungoid and other troubles, which develop in transit, have been studied in detail.[12]

In Western Australia the industry has been developed on alluvial areas near Carnarvon (lat. 25° S.). Water is supplied by pumping from the underground water in the bed of the Gascoyne.

Pineapples are cultivated in the coastal areas from the Tweed River northwards along the Queensland coast (Plate 62). They provide the requirements of the Australian markets, and the surplus is canned.

The requirements of the crop are freedom from frost, a satisfactory aspect giving protection from cold westerly winds, a rainfall which is reasonably high but not high enough to cause water-logging, and an acidic, friable soil. The best plantations are well advanced in their methods of propagation and management. Replanting after every third crop is the usual practice. Contour planting is not generally practised, and erosion is difficult to avoid on all but the most penetrable soils. So far there is no rotation practised, but experiments are being carried out to find suitable plants for this purpose and Pigeon Pea (*Cajanus indicus*) seems to be promising.

Pawpaws are almost entirely a Queensland fruit. They grow readily in all the better rainfall regions which are frost-free, but little has been done in the way of selecting and improving the varieties grown. Investigations are being made into methods of improving yields by hand pollination, and by a better selection of soils.

Mangoes, Custard Apples and Avocadoes grow readily in suitable locations, but a considerable amount of detailed work will be necessary in selecting or breeding varieties, in building up techniques of cultivation, and above all in stimulating a taste for these delicacies in the larger centres of population before the possibilities of these fruits are fully known on the Australian market.

11. See Young, W. J., *et al.*, 'The Ripening and Transport of Bananas in Australia,' *C.S.I.R. Bulletin*, No. 64.

12. See McLennan, E. I., and Hoette, S., '*Nigrospora musae* and its Connection with "Squirter" Disease in Bananas,' *C.S.I.R. Bulletin*, No. 75.

Simmonds, J. H., and Mitchell, R. S., 'Black End and Anthracnose of the Banana,' *C.S.I.R. Bulletin*, No. 131.

Hicks, E. W., and Holmes, N. E., 'Further Investigations into the Transport of Bananas in Australia,' *C.S.I.R. Bulletin*, No. 91.

Chapter XII

OTHER CROPS

1. Cereals
    (a) Winter—Oats, Barley, Rye
    (b) Summer—Maize, Sorghums and Millets, Rice
2. Leguminous Field Crops—Peas and Beans, Lupins, Soya-beans, Peanuts
3. Potatoes
4. Cruciferous Field Crops
5. Tobacco
6. Fibre Crops—Cotton, Flax, Linseed
7. Vegetable Crops

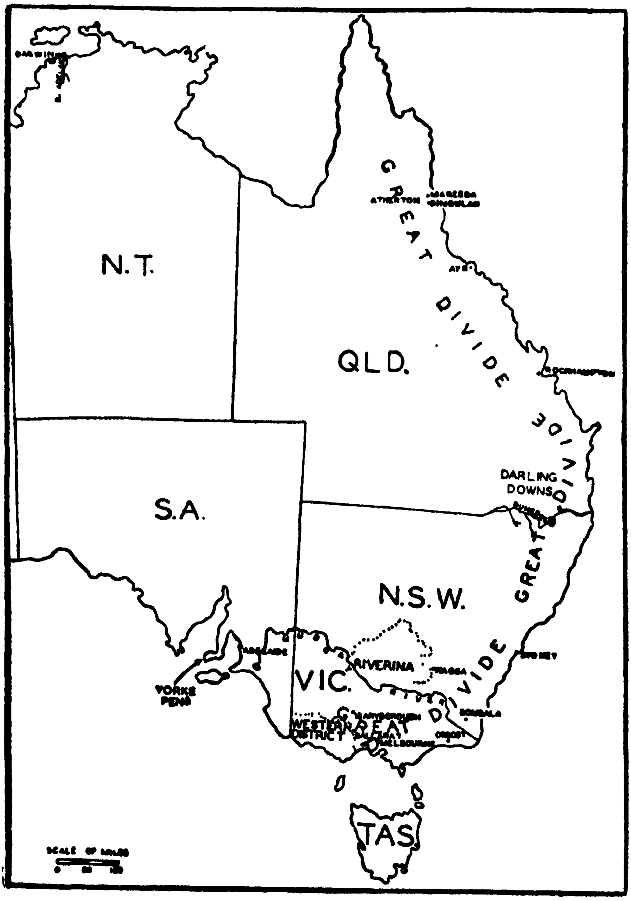


Fig. 65. Key map to geographical names not shown on the figures hereunder and not referred to on maps in following chapters

Chapter XII

OTHER CROPS

1. CEREALS

(a) Winter

Oats

Average Annual Acreage of Oats Grown for Grain by States for ten seasons ended 1944-45

	Thousand acres
New South Wales	347
Victoria	493
South Australia	325
Western Australia	411
Tasmania	21
Queensland	12
Commonwealth	1,609

Source: *Summary of Crop Statistics,* Vol. 1, No. 2 (Commonwealth Bureau of Census and Statistics, Canberra).

N.B. These acreages are for areas 'intended for grain' only. The total acreage of oats in Victoria, for instance, would be about two and a half times the figure shown.

Among this group of 'other' crops, pride of place must be given to oats. The widespread cultivation of this crop is due to the variety of purposes to which it can be put. The grain has, of course, been regarded for centuries as first-class horse feed. In the southern states it is also largely used as a reserve food for sheep at times when pasturage has become exhausted; a ration of half a pound of grain per day is usually sufficient to keep a sheep alive. The practice of growing oats for cereal hay (Plate 63) is widespread in those districts where the type of pasture does not lend itself to the production of meadow hay. In localities where oats grow luxuriantly, and will give average yields of about two tons or more of hay to the acre, this form of agriculture becomes the dominant activity on many farms. In other places it is normal routine for farmers to grow enough hay for the needs of their own stock. The cultivation of oaten hay is particularly concentrated in the Wagga Wagga district of New South Wales and on the better soil areas of the Ballarat-Maryborough region in Victoria. In those parts of the wheat belt where fat lamb production is the vogue, and where pasture growth is scanty, many farmers plant an area of oats so that there may be more grazing for the ewes as soon as the weather breaks in the autumn. In bad years oats will grow faster than the natural herbage during the winter

months, and in good seasons this acreage, instead of being fed off, may be used as a crop for hay or grain.

The ordinary varieties of the broad-leaved oat (*Avena sativa*), grown in northern Europe, do not usually give satisfactory results in most parts of Australia. In the main cultivation belt such varieties come to harvest too late to avoid the dry summer period; they are, however, satisfactory for Tasmanian conditions and in cold late upland regions. The Algerian oat (*Avena sterilis*) and its selections are widely cultivated; their small leaves and earlier time of harvest fit them for the conditions of the main zone of cultivation. Special, early-ripening hybrids of this and the preceding species have been produced by plant breeders for Australian conditions.

The production of oats for grain is governed by their market value. They can be grown more readily than wheat, but their lower value on the world market, and the extra bulk they occupy in shipping space, prevent the development of an export trade of any size. In the future the tendency for stock-owners to use more supplementary feeds may well lead to some expansion in the area used for their cultivation; but, on the other hand, the replacement of horses by tractors, and the increase in pasture improvement with its necessary adjunct, the collection of meadow hay, will tend to reduce the acreage of oats grown for hay.

Barley

Average Annual Acreage of Barley Grown for All Purposes by States, for ten seasons ended 1944-45

	Thousand acres
New South Wales	17
Victoria	142
South Australia	394
Western Australia	60
Tasmania	6
Queensland	10
Commonwealth	629

Source: *Summary of Crop Statistics*, Vol. 1, No. 2 (Commonwealth Bureau of Census and Statistics, Canberra).

Barley has been cultivated in Australia since the early days of colonization. In most districts it is an effective crop as far as yield is concerned. In the drier areas the 'feed' types are the more successful. Wheat farmers do not usually favour barley as an alternative crop, both because it is liable to some of the same diseases as wheat and also because the 'feed' types are liable to produce seeds which lie dormant in the soil, and germinate in the ensuing

wheat, among which they are an undesirable weed. In moister regions, particularly near the coast, where night dews may be expected at harvest time, the 'malting' types are frequently grown with success. The best districts are the Yorke Peninsula, in South Australia, but also certain areas in Victoria, Western Australia and Tasmania. The effect on the market of this variation in quality is very noticeable. Feed barley is usually fairly low in value, and the world market price is seldom high enough to stimulate an export trade. There is, however, some demand overseas for the malting quality, and in peace time the local market is usually stabilized by this influence. Before 1939 the total exports of barley were usually of the order of two million bushels, while the local market took two and a half million for malting. Prior to the development of this trade on a regular basis, the price which the local market offered for malting types varied widely from year to year, according to whether supplies were abundant or only to be obtained as a result of hard bargaining.

Historically, malting barley was seldom grown successfully in Australia until a special variety was developed to fit in with the earliness of the harvest season in Yorke Peninsula. This is another instance of the need for the development of some special feature or process before an industry could find its feet in the Australian environment. The point that effective progress was largely dependent on the development of an organized export is also noteworthy.

During World War II the Commonwealth controlled the marketing of the crop and fixed the prices at which it was to be sold, an Australian Barley Board being set up for these purposes. In the earlier years large stocks accumulated, but successive bad seasons from 1942/43 to 1944/45 and the large demand for animal foods, both by the pig industry and for drought feeding, reduced the surplus rapidly. The further expansion of the barley acreage is bound up, on the one hand, with the possibility of an increased demand for feed types by the pig industry, and, on the other, with an expansion of the Australian share of the world market for malting quality. Both types could be produced on a much larger scale than at present.

Rye

Rye has attracted little attention in Australia. The demand for the grain is small, and few farmers cultivate the crop. The total area under rye in 1944/45 was 32,000 acres, yielding 68,000 bushels, of which 55 per cent was produced in South Australia. It is mainly produced in localities from which a demand for the straw is expected, although there is a small consumption of rye flour. It has the capacity to grow on windblown sandhills in eroding areas, and is useful as a soil protector under such circumstances, although it usually fails to set seed owing to its late flowering.

(b) Summer

These crops are naturally limited to districts with reliable summer rainfall, or to irrigation areas.

Maize

Average Annual Acreage Cropped to Maize for Grain by States for ten seasons ended 1944-45

	Thousand acres
New South Wales	116
Victoria	14
Queensland	176
Commonwealth	306

Source: *Summary of Crop Statistics*, Vol. 1, No. 2 (Commonwealth Bureau of Census and Statistics, Canberra).

Maize is by far the most important of the summer cereals. It is grown for grain, and for silage or green feed for dairy cows. The principal grain-producing districts are the Atherton and other tablelands of the ranges in Queensland and northern New South Wales and the river alluviums down the eastern coast and into Victoria. Where soils are rich and deep, and moist conditions prevail, crops are large. The alternative use of the maize land would, in most cases, be for dairy pastures. The competition of dairying on these lands probably prevents some expansion of maize-growing, since the high returns from butter-fat make cultivation less attractive. The grain is mainly used either for manufacturing purposes or for feeding pigs, and it is sometimes fed to sheep during droughts. It is almost entirely consumed within Australia; the world market price is usually considerably lower than that obtained for the local product, protection being afforded to the industry through the operation of the tariff.[1]

The present position of the industry does not make a very good showing, and an assessment of the future prospects of maize as a crop presents some difficulty. Breeding work on maize has been revolutionized in America during the last two decades. The same methods are in course of development in Australia, but have not yet borne fruit. Modern analytical methods of field experimentation have not yet been applied to maize on a wide scale, nor have the various possibilities in connection with widened rotations been fully investigated. There is evidence that in some districts, e.g. the Atherton, the yields have declined during recent decades. It may be that careful experimental and educational work will improve the effectiveness of the industry and lower its costs of production. Until such a development occurs there is no prospect of any considerable expansion of maize-growing, for the industry

1. The present rates are: British Preferential 2s. 6d. per cental, General 3s. 6d. per cental.

is not specially profitable in comparison with alternatives under existing conditions, despite the relatively high Australian price.

Maize requires deep fertile soils, and the area of these within the high summer rainfall zone is limited. The Darling Downs of south-east Queensland include large tracts of black soil, some of which are very fertile. At first sight it might be expected that maize-growing would extend widely on these areas; the chief obstacles, however, are the relative unreliability of the rainfall and the liability of this region to hot, dry winds from the interior at the most vunerable stage, when the maize is coming into flower. The number of cases where individual growers have experienced poor crops for this reason seems to be a sufficient deterrent to prevent others from following their example. Another reason for the small amount of maize grown in summer rainfall regions, when compared with those of the United States, is the comparative backwardness of the pig industry in Australia, a fact which, in its turn, is dependent on the competitive power of mutton, a by-product of the wool industry, as a national food. The possibility of a further utilization of this crop for green feed for cows is dependent both on the development of better varieties, specially suitable for this purpose, and on the extension of more intensive methods of feeding such stock during the off-season of pasture growth.

Sorghums and Millets

Sorghums and millets are chiefly grown as reserves of fodder in dairy districts where climate and soils are not satisfactory for maize, and also as summer fodder for sheep, and for grain in the northern parts of the cereal belt, where the acreage has far exceeded 50,000 since 1940/44. The acreage is not large, and could be considerably increased. This is particularly true on the Darling Downs, where recent experiments have suggested that improved varieties have a promising future, the grain being harvested by modern mechanical methods, while the stover is available as roughage for cattle during the dry winter. More investigation seems to be necessary in order to ascertain the most effective rotation: this must take into account the extreme liability of this country to erosion during the heavy downpours which are characteristic of its summer climate.

Two virtues of this crop which should commend it to the northern wheat-growers are that it can be harvested with the same machinery with but slight adjustment, and the seeding cost of 3s. per acre is exceedingly light. In the southern irrigation districts (Fig. 70), a hundred bushels per acre could be expected, but its water requirement is high. The Commonwealth guaranteed price in 1946 was 3s. 7d. per bushel.

At present pasture improvement is the order of the day, and progressive dairy farmers are concentrating their attention on making their grasslands more productive; probably time will show that on certain soils better results

can be achieved by the development of long rotations of sown pasturage, with periodic reversion to cropping. Grain sorghums are seldom, if ever, grown as human food. There are no agricultural areas so economically 'depressed' as to require the population to have recourse to this form of grain. Millet is produced in a few districts in Victoria and New South Wales.

Rice

For many years small plots of rice were grown on the river flats of the Murray and other areas. From time to time the possibility of introducing large-scale cultivation of rice was discussed. The first serious attempt to produce the crop on a commercial basis was made on the Murrumbidgee irrigation area, near Yanco (Fig. 70), in 1924-25, when an area of 153 acres was planted, and the yield was over a hundred bushels of paddy per acre. It was realized that, with cheap irrigation water, there was a future for the crop on some of the soils in this locality which were too heavy for the cultivation of fruit, the staple crop of the district. The chief problems which had to be solved were, first, the introduction of correct varieties adapted to the climate and latitude of the district; and, secondly, the construction of suitable harvesting apparatus which would enable the growers to reap the grain without an undue expenditure of labour. Californian varieties of rice were found to be suitable, and the mechanical rice-harvesters which were developed have enabled the Australian grower to reap the paddy without having to rely upon a large amount of casual labour.

The industry was partly fostered by tariff protection,[2] and production rapidly overtook the Australian consumption. In view of the relatively small area of Australia in which conditions comparable with those of the Murrumbidgee prevail, it was not likely that Australia would ever develop a sufficiently large production to be an important factor in the world market, nor did it seem urgent that she should do so. During the decade 1930-40 the general demand for irrigation water steadily increased, and it became clear that the large quantity of water required for rice growing (at least six feet per acre being a normal supply) would place too great a strain on the limited water resources available unless the acreage under the crop were controlled. It was, therefore, decided to limit the rice acreage and, at the same time, to ensure that cultivation was carried out in an efficient and practical manner. A Rice Marketing Board was set up in New South Wales, and a Rice-growers' Association was also constituted. Each year representatives of these two bodies confer with the State Director of Agriculture, the State Director of Marketing, and a representative of the Water Conservation and Irrigation Commission, to determine the acreage which may be planted by each settler.

After planting, the areas are surveyed by order of the Rice Marketing

2. The present tariff rates are: for uncleaned rice, 1d.; and for other types, 1½d. per lb.

Board, and settlers are required to draw the water off any area planted in excess of the allotment. The Water Commission will not supply water for such excess. Under these circumstances, a reasonable degree of control has been possible. In 1935, the net return to settlers was about £8.10.0 per ton. The price for paddy, for home consumption, was £11 per ton, while that for export brought £7, both prices f.o.r. at the railway siding.

Under these conditions, those rice-growers who developed an efficient technique and rotation made a reasonably good living, and the market was kept fairly stable at a home price which was not unduly high. Such a state of affairs could not have been achieved had rice-growing been possible on wide acreages and in several states, since, on the analogy of other commodities, the home market would probably have had to bear the burden of maintaining the export of large quantities at a low price.

Rice production and other related figures are shown in the following table:

Year	Area (Thousands of acres)	Production Paddy Rice (Thousands of bushels)	Average Yield (Bushels)	Imports (Thousands of cwt.)	Exports (Thousands of cwt.)
Average for five seasons ended 1938-39	22·8	2,275	100·33	36	233
1939-40	24·1	1,858	77·02	27	283
1940-41	24·5	2,240	91·26	23	189
1941-42	23·6	2,192	92·75	33	226
1942-43	34·2	3,084	90·11	2	220
1943-44	40·7	4,015	98·67	—	706
1944-45*	24·6	1,693	68·82	—	403
1945-46	28·4	2,735	96·40	—	375

*Conditions were very adverse.

Computed from *Production Bulletins* (Commonwealth Bureau of Census and Statistics, Canberra).

During World War II a new factor appeared in the necessity to grow more rice for food for some of the native populations in the South Pacific whose normal sources of supply had been cut off by enemy action. Increased acreages were therefore planted on the Murrumbidgee, and a new rice project was initiated in the Wakool irrigation area (Fig. 70); these efforts led to an increase in production in 1943/44, as the above table shows. Meanwhile the cultivation of the crop on some of the Murrumbidgee soils which were rather more porous than those normally used led to an increased seepage and a corresponding rise in the water-table in parts of the district. This brought about a general appreciation of the need for great care in controlling the soils used for the crop. When the Japanese overran the Southern Pacific, the Australian crop was diverted to the islands remaining in Allied hands, and the home market was denied supplies.

Rice production has never found a permanent place in the wet coastal areas of Queensland, largely owing to the high humidity during the harvest season which hindered mechanical harvesting. It is possible that, if irrigation could be developed in some of the other areas in the north of the continent, a suitable place for further development might be found.

2. LEGUMINOUS FIELD CROPS

Peas and Beans

For 1944-45 the total area under peas and beans, grown for stock fodder (excluding those grown as vegetables or green manure) was 41,000 acres, chiefly in South Australia, Western Australia and Victoria. The dried pea and bean acreage in the same season was 37,000. Before World War II Tasmania was the main exporter of dried peas. Neither peas nor beans have occupied a prominent place in the agricultural system, except in a few isolated districts. Here and there they have been tried as winter crops, but with only occasional success. Consideration of one or two instances may suggest the reason for this comparative failure. In one district on the Adelaide Plains field peas were tried as an alternative crop to wheat and in lieu of fallow, the harvest being either sold for seed or fed to sheep during the dry months of summer. However, after a few years, the ravages of the pea-moth and other insects became so bad that the venture would have been a failure had not further experiments been carried out, using early varieties. In moist seasons, the crop is sometimes adversely affected by the thrips insect and by a fungus which attacks the roots of the plants. A second instance may be taken from the Orbost district of Victoria, where satisfactory production of the Canadian Wonder variety of French beans has been developed. Considerable quantities of this seed were produced, and a proportion was exported. The spread of a bacterial disease crippled the industry for some years. A new variety which is resistant to the bacterium has now been developed, but this has not quite the same pod qualities as the original Canadian Wonder. The problem thus becomes one for the combined efforts of the plant pathologist and the plant breeder. It seems fair to suggest that the frequent failures of other leguminous plants may be largely due to lack of technical assistance by specialists.

Lupins

This crop, which revolutionized agriculture on the poor sands of north Germany, has been found most successful on parts of the coastal strip south of Geraldton (Western Australia, Fig. 71), where early lupin varieties are grown. Its seeds are used for sheep feed during the summer, and at the same time the fertility level of the soil is raised. It is, however, limited to a region with moderate rainfall and free from extensive frost periods, while it can only maintain itself by reseeding where summer rains are very exceptional.

Soya-beans[3]

Soya-beans should be a satisfactory crop when varieties adapted to the climate of various localities have been obtained. Until recent years the soya-bean received little attention, probably because the local market was not interested in any of its special features. Protein cattle-cake and nuts are used somewhat sparingly in Australia, and soap-makers and other industrial users have normally been able to obtain their fats from animal sources or copra from the Pacific.

Recently, propaganda in favour of soya-beans for use in cooking, on the one hand, and the development of their use in the veneer and plywood industry on the other, have altered the position, and there seems some reason to expect progress in the near future. Any new cash crop will be advantageous to Australia, particularly one belonging to the leguminous family. The difficulty lies in obtaining varieties with the appropriate growing period and in developing mechanical methods of harvesting the seed. Similar problems have been solved in the U.S.A., and there is no reason why research should not be equally successful in Australia. In the southern states, however, the crop will only be practicable in the very restricted areas which have adequate summer rainfall or which are under irrigation. In the former districts the crop will have to compete economically with peas and beans. In some northern areas where summer rainfall is reasonably reliable and conditions in the harvest period are not too wet, the crop may be expected to develop in the future.

Peanuts

Peanuts are grown in sandy loams in the tropical regions of the continent where the rainfall is reliable. In 1944-45 there were 19,000 acres in Queensland along the coastal region, anl before World War II a few growers were located in the Northern Territory, in the Darwin region. The crop is consumed within the Commonwealth, and is protected by a tariff.[4] The value of this type of crop in a rotation, and the need for its cultivation only as part of a rotation, has not been generally realized. No satisfactory machines are available for mechanical harvesting and the bulk of the crop is still harvested by hand. Threshing is usually done by contractors who operate the machines. Silo storage facilities are provided by the Queensland Peanut Board, which is also associated with the marketing of this crop.

The paramount importance of the role played by leguminous plants in general in maintaining the level of nitrogenous compounds in the soil has

3. The practicability of developing soya-bean as an Australian crop is discussed in 'The Soya-bean Industry,' *Report of the Commonwealth Mission of investigation into the industry in U.S.A. and on its possible establishment in Australia,* by Bullcock, F. W., Mullett, H. A., McKeon, C. J., and Grantham, H. A. (Commonwealth Department of Commerce and Agriculture, Melbourne.)

4. The present tariff on unshelled nuts is: British Preferential Rate, 2d. per lb.; General Rate, 4d. per lb.

been recognized for centuries. In new countries, with agriculture in the exploitative phase, the significance of this role tends to be overlooked. This has certainly been the case in Australia.[5] The presence of moderate amounts of phosphate in the soil is a pre-requisite for the cultivation of most plants of this family; and many soils, in southern Australia at least, are markedly deficient in this nutrient. The practice of manuring with phosphates is causing the extensive distribution of volunteer clovers among pastures and, to some extent, on crop land which has an annual rainfall of over fifteen inches. In the summer rainfall zone, herbaceous legumes are not so prevalent, nor is top-dressing with phosphate at all general. The status of many northern soils in respect to both phosphate and nitrogen is obscure. It seems likely, therefore, that the legumes will assume greater prominence in the rural economy of the farming areas of the continent. Their general value as animal foodstuffs will make the absorption of their extra production relatively simple if the maintenance of stock on a high plane of nutrition also extends.

3. POTATOES

Potatoes are cultivated chiefly in districts with moderate temperatures, and with rainfall fairly well distributed in the season during which the crop is produced. In most parts of Queensland the tubers will not keep long, and their place in the national diet is partly taken by the Sweet Potato. As a result, the chief producing states are Tasmania and Victoria, each of which has an export to the other states (Plate 64). In Western Australia certain swamps near the coast in the South-Western Division, being frost free, are able to produce very early crops which are often shipped to eastern states. In this state later crops are grown on such swamps and also on irrigation areas. The following table sets out the average acreage and yield per acre by states for ten seasons ended 1944-45:

	Thousand Acres	Yield per Acre (Tons)
New South Wales and A.C.T.	23·1	2·4
Victoria	48·1	3·4
South Australia	6·1	4·7
Western Australia	6·1	4·9
Queensland	12·4	1·8
Tasmania	41·1	3·5
Commonwealth	136·9	3·3

Computed from *Production Bulletin,* No. 39 (Commonwealth Bureau of Census and Statistics, Canberra).

5. Scientific investigation suggests that the role may be even more significant than is usually thought. The accepted theory is that the soil nitrogen is augmented by leguminous crops, by atmospheric electrical discharges, and by fixation of free nitrogen through certain free-living soil bacteria, among which the genus *Azotobacter* is most important. It has been shown that *Azotobacter* is negligible or absent from many soils of the wheat belt. If there are no other free-living nitrogen-fixing organisms in these soils, cropping must necessarily result in the gradual depression of their nitrogen level, except in so far as that level is maintained by the activities of the leguminous plants with their special races of symbiotic bacteria.

The yields per acre are definitely low, partly because the crop is, to some extent, specµlative. They are highest in the states with the smallest acreage, because they are only grown there under the most advantageous conditions. In general, the crop is not produced as part of a long-term rotation, but is regarded by some growers as a speculative enterprise, and many areas are depleted in fertility by continuous potato growing. In the occasional seasons in which supplies are short, prices rise to a high figure, which stimulates farmers to continue producing the crop through periods when prices are unremunerative. Such wide disparities in price inevitably lead to some speculation. Another reason for low yields is the prevalence of virus diseases,[6] and the lack of appreciation by some growers of the need for virus-free seed. In Tasmania and Victoria the Agricultural Departments have taken this matter in hand, and have arranged for the production in elevated districts of virus-free seed potatoes which are available for main crop producers. These developments have increased the average yields in recent years.

Diseases other than those due to viruses are also common among the crop, as in other countries; so far, the deadly black scab has been kept out by careful quarantine precautions. Irish blight is occasionally troublesome; eel-worm has been devastating on farms where rotation has not been practised, and where seed selection has been neglected. Potato moth is serious in some seasons.

Potato growing does not exert a great effect on land utilization, measured by the actual extent of area occupied, but the crop is grown in districts with a good agricultural climate and the land is frequently of high quality. Any land released from potatoes could be readily used for other purposes.

During World War II large extra amounts of potatoes were required for the Services, and many dehydrating plants were erected. The extra crop was stimulated by offering high prices to farmers. The subsidy was finally abandoned in 1948. It is too early to forecast the future size of the industry.

4. CRUCIFEROUS FIELD CROPS

In the cooler parts of the north temperate zone, the cruciferous crops play an important role in agriculture; cabbages, turnips and swedes act as efficient reserves of stock food during the colder months, while rape and kale are recognized as rapidly-growing catch crops valuable under certain circumstances. In Australian agriculture, these crops are little grown. They require a more humid climate than the dry wheat belt can offer; and, in moister regions, farmers tend to grow summer cereals for autumn requirements and to rely on pastures for winter feed. Crops of rape and field turnips are occasionally grown for sheep feed in the cooler regions.

6. Bald, J. G., and Norris, D. O., 'Transmission of Potato Virus,' *C.S.I.R. Bulletin*, No. 163.

5. TOBACCO

Area under Tobacco and Yield of Dried Leaf
(Average for ten seasons ending 1944/45)

	Acres	Yield per Acre (Hundred lb.)
New South Wales	757	8
Victoria	2,998	5
Queensland and Northern Territory	3,626	6
South Australia	37	2
Western Australia	1,117	8
Tasmania	61	6
Commonwealth	8,596	6

Source: *Summary of Crop Statistics*, Vol. 1, No. 2 (Commonwealth Bureau of Census and Statistics, Canberra).

For many years this crop was planted in a few localities in various parts of Australia. The tobacco is a large-leaved plant, which develops at a rapid pace during the summer months, and it is limited to districts in which there is sufficient rain or irrigation water, and a fairly deep soil which allows easy penetration by the roots. Various isolated situations in the valleys and tablelands of the ranges in all three of the eastern states fulfil these conditions.

The leaf which was produced in Australia under these conditions was usually of a dark colour, and was often more suitable for the production of insecticides and 'plug' than for smoking tobacco. The growers usually had little detailed knowledge of the technique which is required for the production of high-grade tobacco, and their produce was not favoured by Australian manufacturers of tobacco and cigarettes. The position of an Australian manufacturer who was willing to purchase from the local growers was relatively difficult. From overseas, he could obtain supplies from large lines of carefully graded material, more or less standardized in curing and maturing, whereas locally he would have to buy relatively small lots from individual growers who differed fairly widely in their ideas as to correct procedure in curing and who sold their product before it had gone through any maturing process.

Under these conditions, it is not surprising that the industry was not an immediate financial success. In 1926, the tobacco interests set aside a fund for scientific investigation which, it was hoped, would put the industry on a sounder footing. The preliminary investigation on tobacco-growing soils indicated that the areas in Australia which were equipped with both suitable climate and soil were relatively limited, and that many of the present areas were not on suitable soils.[7] Research into the smoking qualities of tobacco were also begun. It was considered that two districts in particular offered

7. Bainbridge, E. P., 'A Reconnaissance of Some Australian Tobacco Soils, with Reference to Reaction and Mechanical Analysis,' *Jour. of C.S.I.R.*, Vol. 1, No. 6, 1928.

possibilities, viz., the Mareeba district on the edge of the Atherton tableland, in north Queensland, and some of the valley soils in north-eastern Victoria.

In the Victorian districts (Plate 65) the crops were frequently damaged by a downy mildew fungus (*Peronospora tabacina*), while in Queensland leaf-spot or frog-eye fungus (*Cercospora nicotianae*) lowered the quality. It gradually became apparent, as far as Victoria was concerned, that accurate experimental work would be virtually impossible until some measure of control of downy mildew had been achieved. In the last few years the difficulty has, in part, been overcome through research work done by C.S.I.R. officers, who have ascertained that, as far as the seedling stage is concerned, the plant can be raised free from infection by the use of benzol vapour around the seed bed. It is susceptible, however, to infections which occur in the field after transplanting, and more experimental work is needed before this disability can be overcome.

The onset of the economic depression, 1929-30, stimulated Australia to examine the overseas purchases of the Commonwealth, in order to ascertain which of them might be curtailed. Tobacco was a reasonable subject for consideration, as the importation in 1928-29 of tobacco in all forms was of the order of twenty-three million lb., costing £2,700,000 (sterling). Accordingly, the tariff was raised considerably and the excise set at a fairly low figure. The result was to increase the number of growers from about 700 to over 5,000 and the acreage from about 2,500 to over 20,000.

Expansion of this order meant that a large number of individuals, with very little experience or knowledge to aid them, set out to grow the crop. In 1931-32, the yield was fairly good, but in the following year downy mildew was very prevalent in Victoria and climatic conditions were unfavourable in Queensland. Since that time, the difficulties of producing the leaf have been better appreciated, and scientific investigations have been developed as a result of an agreement in 1933, under which the Commonwealth government was to provide £20,000 a year for investigational work by the C.S.I.R. and the various states. The position in 1943 in the four main districts was as follows[8]:

(1) *North Queensland*

'Mareeba and Dimbulah areas (with which can be included the tobacco grown in some of the coastal areas of Queensland). These tobaccoes are of fine to medium texture, and possess good bright colour and good to very good smoking quality. Their colours show a decided tendency to darken during ageing. In smoking quality they are mild in body and strength; burning qualities are good, and the ash light-grey to grey in colour. Tobacco of this type is similar to flue-cured tobacco grown on sandy soils in the tropical

8. Marks, G. H., 'Classification and Grading of Flue-cured Tobacco grown in Australia,' *Jour. of C.S.I.R.*, Vol. 16, No. 4, 1943.

climates of North America or Rhodesia, but more closely resembles Rhodesian than American tobacco.

(2) *Dumaresq Valley*

'These tobaccoes are medium to heavy in texture and more resinous than those from north Queensland. In smoking quality they are of medium body and strength; burning quality is good, ash is grey to dark grey in colour. In these respects they are more like American tobaccoes than those grown in any other area in Australia. Rainfall is supplemented by irrigation, atmospheric humidity is relatively low, and the soils generally are more fertile than those used in north Queensland.

(3) *North-East Victoria*

'The tobaccoes are thicker, more gummy and generally darker in colour than in districts of type 1 or 2, and in smoking quality are heavier-bodied, stronger, and fuller. Burning qualities are usually good, and ash varies in colour from grey to dark. Rainfall is supplemented by irrigation, but the mean temperature is lower and the soils a little more fertile than in type 2 districts.

(4) *Manjimup, Western Australia* (Fig. 71)

'This type is fine to medium in texture, generally light in colour, very mild in smoking quality, and has comparatively good smoking aroma. The burning qualities, which are sometimes poor, have an important influence on smoking characteristics.

'The difficulties which have beset the development of the tobacco-growing industry have been typical of those experienced in the early stages of many Australian industries. To some extent, they are more acute in this particular case, partly because of disease problems, and partly because of the number and complexity of the factors which influence quality in a crop which is meant to please the human palate. In addition there has been failure to recognize the fact that the soil which grows a crop is changed during the process, and that a rotation is necessary if the quality is to remain steady.'

6. FIBRE CROPS

Cotton[9]

Cotton was first grown on a commercial scale in Queensland in 1852, when seventy bales of lint (the fibre obtained from the boll or seed-pod) were shipped to England from the district around Brisbane. The quality of the fibre, and the high prices realized, aroused so much interest in England that a stream of immigrants started to the colony to grow cotton. Although handicapped by inadequate transport facilities, the new settlers travelled in all directions from Brisbane, and cotton-growing on an extensive basis could

9. Much information in this section has been obtained from the *Tariff Board's Report on Raw Cotton*, dated 15 October 1945. (Govt. Printer, Canberra.)

soon be seen along most of the rivers of south-east Queensland in much of the district lying between Brisbane and Toowoomba.

The American Civil War interrupted the growing of cotton in the United States, and further stimulated interest in the crop in Queensland, and by 1871 the annual production had risen to 2,500,000 lb. of lint. For the period 1868 to 1873, a total of 20,044 bales of lint, each of 500 lb., was exported to England. Cotton-growing appeared to be well established in the colony, but the resumption of cotton-growing in the United States following the cessation of the Civil War soon caused prices to fall to unprofitable levels for the Queensland growers, who had to bear high costs of transport to the British market. By 1887 the industry had practically expired in this country, but, as A. J. Boyd[10] has pointed out, cotton was undoubtedly the means of settling much of the south-eastern part of the colony, and the returns realized from the crop placed the settlers in a position to engage in other agricultural industries after cotton-growing became unremunerative.

The cotton industry, however, proved to have remarkable vitality, and was resurrected in the early 'nineties. The peak of this period was 1895, when 269,110 lb. of unginned cotton were produced. During the years 1890-97 a cotton spinning and weaving mill operated at Ipswich. After 1895, production flagged once more, but rose to a peak in 1911, when 186,894 lb. were produced from 605 acres. In 1913 the Queensland government made a serious attempt to revive the industry. Cotton seed was purchased and distributed gratis to farmers. The raw cotton was handled by the government, who ginned, baled and marketed the crop for the growers in Australia and England. However, the attempt was unsuccessful, and the fall from the 1911 figure continued, until in 1916 there were only 76 acres, producing 24,264 lb. of unginned cotton.

At the close of World War I, prices rose to such attractive levels that the Queensland government decided to attempt the development of the industry again. The earlier period had demonstrated that cotton of good quality could be grown in much of the south-eastern part of the state; and, with the reduced production of cotton in the United States caused largely by the inroads of the boll weevil, it appeared to be an opportune time to revive the industry. Accordingly, a guaranteed price, commensurate with that ruling at the time, was offered in 1919, when 37,238 lb. of cotton was grown. The interest aroused by the returns brought about a quick expansion in cotton-growing, the area under crop in the 1921-22 season being 8,716 acres, which yielded 3,858,024 lb. of seed cotton.

An agreement was made with the Australian Cotton Co-operative Association to establish ginneries and an oil mill for ginning the cotton and treating the resultant seed. Steps were also taken to develop an organization in the Department of Agriculture to ascertain the best methods of growing

10. See *The Queensland Agricultural Journal*, January-February, 1914.

cotton, to evolve satisfactory varieties, to grade and supervise the ginning of the crop, to facilitate profitable marketing, and to advise farmers.

Interest in cotton-growing increased in a surprising fashion, and was further stimulated by the Commonwealth government agreeing to share equally with the state any losses incurred through the guaranteed prices. This applied to all the states, and investigations were carried out in the most likely parts of the other states to ascertain the possibilities of cotton-growing. Sufficient seed was distributed in Queensland in the 1922-23 season to plant

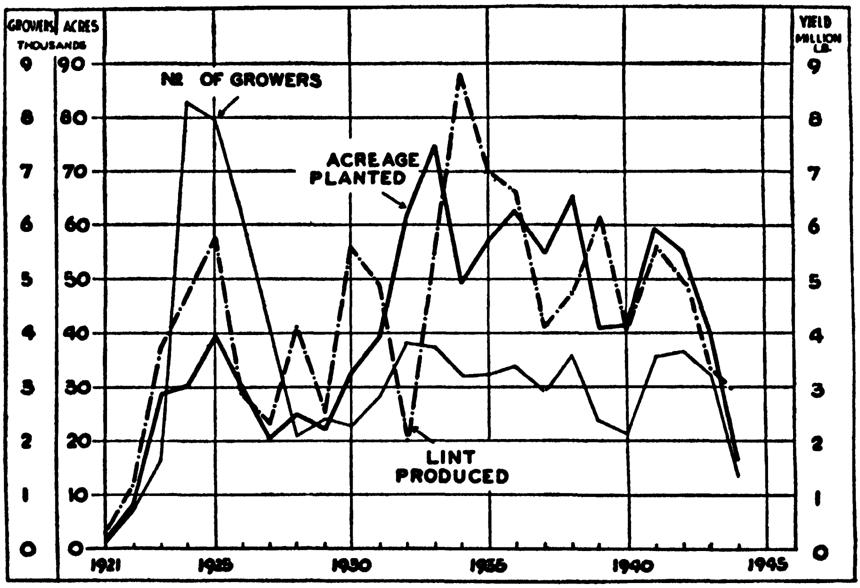


Fig. 66. Progress of cotton-growing in Queensland

(Based on information kindly supplied by the Bureau of Industry, Brisbane, and on the annual reports of the Queensland Cotton Board.)

Areas used in the above graph are areas planted; no information is available as to areas actually harvested, and at times there are considerable differences between the two. The yield per acre planted is more significant than the yield per acre harvested, since expenditure on cultivation and planting of areas not picked is dead loss.

50,000 acres, and, as was to be expected, cotton-growing was tried on all classes of land and by all sorts of people. Cotton-growing companies, in which people purchased shares at high prices, were formed; land values rose to absurd levels in the districts producing the highest yields, and the inevitable collapse occurred with the first season yielding poor results, which was, fortunately, in 1922-23. It was clear that cotton-growing, like any other crop, required sound agricultural practices. Nearly the same acreage was planted in the following season, but failure to increase the average yield caused a marked reduction in the area in 1925-26. If any attempts were then made in states other than Queensland they had ceased by 1925. Thereafter the industry was confined to Queensland south of the Tropic of Capricorn. At

the outbreak of World War II, Australian cotton provided less than thirty per cent of the local demand.

The progress of cotton production in Queensland since 1921 is shown on Fig. 66. The increased production in 1941 was caused by increased prices and statements by the government that cotton growing was important to the war effort. The decrease from this year onwards was due to shortage of labour and to increased dairy product prices.

Location

The establishment of the cotton-growing industry in Queensland has been valuable in developing certain areas of this state. Much of the cotton is grown in districts with a mean annual rainfall, varying from twenty-five to thirty-five inches, characterized by very irregular distribution and intensity of occurrence. In many of these districts the yearly evaporation is, approximately, sixty to seventy inches, and crops with marked drought-resistant properties are required. Cotton has been proved to be eminently suitable for such conditions, both because of its drought-resistant properties and of its relatively high value per unit weight, as compared with any other crops that can be grown. However, climatic studies indicate that Queensland cotton areas do not compare favourably with those in other parts of the world either for total rainfall or for its distribution over the growing period. Only on a few occasions, over more than twenty years, have seasons been even reasonably good for cotton growing. The fact that climate in Queensland is less favourable than in the United States of America seems now to be generally admitted. The difference in the regularity of yields in the two countries is caused at least partly by differences in climatic reliability. It is doubtful whether cotton farming in dry areas will ever prove an attractive industry in Australia.

The soils of the Queensland cotton-growing area show considerable variation, a feature which distinguishes it sharply from the other cotton-growing regions of the world. The wide areas of uniform country with a high-grade type of cotton soil, which characterize the irrigated delta of Egypt or the 'regur' or black-soil plains of India, are lacking.

The areas which experts of the Queensland Department of Agriculture and Stock consider may be ultimately suitable for cotton-growing when irrigation facilities and cheap electrical power are available are shown on Fig. 67.

Production

There are three main systems of cotton-growing in Queensland. These are:

(1) As a rotation crop on dairy farms where the renovation of worn-out pastures has become important.

(2) On newly cleared land or land leased by share farmers who rent areas for a few years at a time. This source of cotton was presumably very

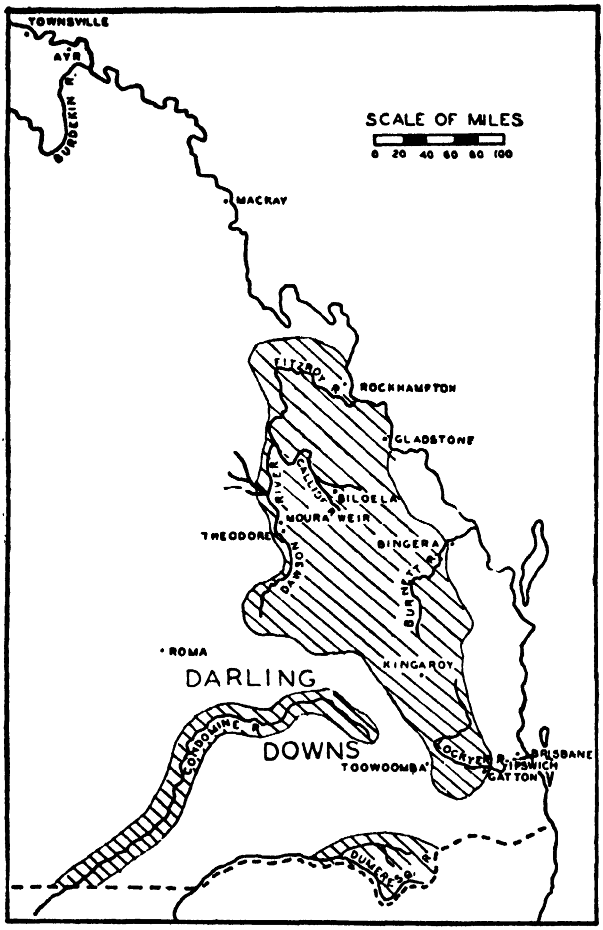


Fig. 67. Prospective cotton-growing areas of eastern Queensland

(Based on information kindly supplied by the Department of Agriculture and Stock, Queensland.)

In 1942 attempts were made to grow cotton in the Burdekin River area, with unsatisfactory results.

The three ginneries are situated at—

Whinstanes, near Brisbane, which is convenient to the south-eastern cotton growing districts;

Gladstone, convenient to the Burnett River areas (this ginnery has not been operated for some years);

Rockhampton, convenient to the Callide and Dawson River areas.

The Cotton Research Station is situated at Biloela. It was established in 1924, with the help of the Empire Cotton-growing Corporation.

important in the earliest years of settlement, when it represented seventy-eight per cent of the total acreage.

(3) Crops on 'scrub burn'. Records kept by the Queensland Cotton Board show that in 1939 and in the two succeeding years crops on 'scrub burn' were responsible for about one-third of the area planted.

It is now recognized that, wherever practicable, cotton should have the benefit of supplementary irrigation. The higher yield obtained from irrigated cotton would improve not only the stability of annual total production, but also the total length and character of the fibre. Because the greater part of the limited irrigated land in Queensland is supplied with water pumped from individual farm wells, the successful development of irrigation with subsurface water is usually dependent upon the supply of cheap electric power. The Moura weir on the Dawson River will serve at least 1,200 acres of cotton.

It has only recently been realized that in Queensland successful cotton growing requires irrigation, and that a permanent cotton growing industry cannot be built on a 'one crop' system of farming. It must be developed in a rotation with other uses of the land, mainly, though not necessarily exclusively, with dairying. It seems to be established that good returns cannot be obtained when cotton is grown for more than two to three years in succession on the same land. On the other hand, it has been demonstrated that cotton can be advantageously used in rotation with Rhodes grass (*Chloris Gayana*) pasture. Both these plants give reduced returns after a few years on the same land; but, by alternating them at intervals, the productivity of both can be restored. Rhodes grass, however, is not readily cultivated in some parts of the cotton area, while lucerne is an alternative to the latter in many places. Nevertheless, cotton is important as a pioneer cash crop on freshly cleared 'scrub burn'. Although it provides only a poor profit to most growers, it is better in the 'burn' than Rhodes grass, which provides still less return in the first year.

The biggest factor operating against the wider production of cotton in Australia is the labour cost, as was shown by the estimates of the Tariff Board's 1938 enquiry. This enquiry showed that labour costs of picking were from 28½ per cent to 42½ per cent of the total cost per lb. of seed cotton. The cost of picking was equal to over 4d. per lb. of raw cotton. Cotton picking is seasonal employment and, therefore, creates social difficulties, although it is said to employ some seasonally employed sugar-cane cutters who would otherwise be unemployed during the cotton picking season.

Seeds of several newly developed cotton varieties with a habit of growth suitable for machine harvesting have been introduced from the United States of America, and are now in the course of multiplication. Trials are in progress to ascertain the suitability of these varieties for Queensland conditions, and the most promising will be used in testing the possibilities of mechanical harvesting.

The bulk of the cotton is grown on dairy farms, where since 1942 the combination of limited labour and increased prices for dairy products and pigs reduced greatly the area planted under cotton. The present import values for cotton of the grade and staple produced in Queensland make the returns obtainable from well farmed cotton in these areas competitive with the returns

which can be obtained from other crops produced, or from industries practised on the portions of the farms where cotton is normally grown. It is anticipated, therefore, that a return of more normal seasons will stimulate a marked revival in cotton growing if prices remain reasonably high.

Marketing and Economics

The cotton is graded by Queensland government graders shortly after arrival at the ginnery, not only to estimate its value, but to ensure the accurate segregation of the different qualities so that a uniform content in each bale of the ginned product may be obtained. As the cotton is graded according to the Universal Standards for American Upland cotton, which is the type of cotton grown here, Queensland cotton can be sold to advantage on any cotton market. Having the marketing of the crop under one central control also allows direct sales to be made to the spinners in Australia without incurring brokerage charges.

The development of the cotton industry under a compulsory pool has permitted the industry to be organized on an efficient basis as far as payments to growers are concerned. All expenses are paid by the pool after the grower places his produce on rail at the nearest station, and approximately eighty per cent of the estimated value of the cotton in each container is paid to the grower within a few days after its arrival at the ginnery.

The manufacturer of cotton goods in Australia has received considerable attention from governments and has gained by assistance from tariffs. In 1935 the Tariff Board recommended an increase in the duty on certain classes of cotton goods. It was also stipulated that the values of Australian cotton should be the gross cost of imported cotton of similar grade and fibre length, in order that the spinners should have every opportunity to produce economically. It was realized that a considerable proportion of these classes of goods could be manufactured from types of cotton of lower value than those which had been more extensively produced in Queensland, because, owing to the necessity of exporting some of the crop, mostly cotton of medium to semi-long staple (which commands good premiums) had been grown. To encourage growers to continue to produce cotton of this higher quality, a scheme of compensating bounties on lint cotton was inaugurated, thus making it possible to sell on the overseas markets. For every 100th of a penny rise above the spot price of sixpence a pound for middling-grade lint on the Liverpool market, the bounty would drop proportionately, until eventually no bounty would be paid when prices rose above elevenpence. This limit was reduced 0·5 pence per pound of lint for the 1935-36 season, with a further similar reduction in 1936-37, the latter level to operate for the next two seasons.

In a report in October 1945 the Tariff Board concluded that the attempt to induce large numbers of farmers to plant cotton with the hope

that they could later be educated towards greater efficiency and reduced costs should be abandoned.[11] It reported in the following terms:

Experience of the past quarter of a century shows that that method had failed, and the Queensland Cotton Board's request for rates of assistance in post-war years, equivalent to those given during the period 1923 to 1927, confirms that conclusion. It is considered that the process should be reversed, and the growing of cotton confined at first to those farmers who are already convinced that, even at lower cash returns per lb. of raw cotton than in the past, it is still worthwhile planting regularly. Expansion should be brought about by convincing other farmers of that fact, if it can be proved to be a fact.

Under the programme recommended, progress will probably be slow and crops small for some years. The Board considers that further assistance should be given the industry by additional payments to cover any increase in the cost of processing and disposing of the crop that can be directly attributed to through-put smaller than in pre-war years.

In its 1939 report, the Tariff Board discussed the question of whether the Australian government should pay bounty approximating the then ruling world price of cotton, to encourage its growing at a time when the United States government was granting assistance to restrict production. The conclusion reached was that the acreage then grown should not be increased until world cotton prices should have risen above the level then ruling. A similar question was raised at the present enquiry by the Indian Government Trade Commissioner.

The intention of the recommendations in this report is to assist the growing of cotton only to an extent justified by its value in diversifying and stabilizing farming in the parts of Queensland concerned. The rate of assistance recommended is measured by the probable value of the crop for that purpose. At the most, the resulting production will be only a small proportion of Australia's requirements and will leave much the greater part of these to be purchased on the world's markets. Australian production in future will have no visible effects on total world production, the most optimistic estimate representing only 0·6 per cent of the world crop in 1938-39 and less than one-tenth of the average yearly fluctuation of total world crops during the twelve years 1924-25 to 1935-36 . . . .

Justification of continued assistance depends upon the adoption by the industry of an objective of growing cotton at low cost for the sake of diversifying and stabilizing farming in the districts in which it is grown. With such an objective, production will at first be small, and it may expand only slowly. The task of achieving stability on a significant scale and in a reasonable time, under the conditions recommended, is formidable. However, provided the expectations of the Queensland Department of Agriculture and Stock and the Queensland Cotton Board as to increased yields, reduced costs and benefits to pastures, can be realized, it should not be impossible if attacked with sufficient energy and intelligence. The Tariff Board considers it justifiable to afford the authorities named an opportunity of attacking the problem under the conditions recommended herein.

Flax[12]

The history of flax growing in Australia, like that of cotton, illustrates the difficulty of introducing a new crop requiring careful location as regards

11. *Tariff Board's Report* on 'Raw Cotton' (Govt. Printer, Canberra, 1945).

12. The authors gratefully acknowledge considerable assistance from Mr. A. A. Lee of the Flax Production Committee in the construction of this section.

soils and climate, careful selection of varieties, and adequate arrangements for processing the product. During the half century prior to 1935 numerous attempts were made to grow flax. At the time of World War I the high price made the crop attractive, but the yields obtained, the quality of the product, and the rather primitive methods used in treating it resulted in little or no progress. Its cultivation was in fact almost confined to a few localities in Victoria. Government bounties, failing to deal with the lack of real technical knowledge of the product designed to stimulate its production, succeeded in inducing few farmers to join the venture, and these failed for lack of the technical knowledge and equipment to make the venture a success.

The sanctions applied against Italy in 1935, by reducing the availability of Italian hemp, increased the need for locally produced soft fibre, and two Victorian spinning companies formed a special company to establish the production of flax on a sound basis in Australia. This company made full use of all available avenues of research and the most modern techniques as practised in the leading flax producing countries in the world. The company also introduced a high-grade pedigreed seed, Liral Crown (from the U.K.), to replace the dual purpose variety previously in use. This company took over or established in Victoria the dew retting mills at Drouin and Strathkellar and the tank retting mill at Colac.

In 1936 arrangements were made by the company with a number of Victorian farmers for the sowing of 200 acres of flax, and this area had been gradually increased to 2,000 acres by 1939. The production of flax fibre during the pre-war period was low and the maximum annual production, which was reached in 1939, was less than 100 tons. At that time, the heavier type of flax goods, such as canvas, were not manufactured here, and Australian demands for line fibre[13] were not large.

Prior to World War II, Great Britain's requirements of line fibre were to the order of 70,000 tons per year, of which only 8,000 tons were produced in the British Empire. The balance of the fibre was imported principally from Russia, the Baltic States, Belgium and Holland. Early in 1940, all these sources of supply were practically cut off by the war. By that time the Victorian company had sufficient seed to sow about 8,000 acres and arrangements had been made with the Commonwealth government for the sowing of the whole of this area, when in May 1940 a request was received from the British government to sow in Australia 13,000 acres of flax on its behalf. The British government supplied the seed, the variety Concurrent, of Dutch origin, forming the bulk of the supply. In order to carry out the request the

13. The fibre flax plant normally contains from 20 to 25 per cent of fibre which varies in length in the one plant. The long fibre, which when extracted is classed as scutched flax or line fibre, usually represents, under commercial conditions, about half of the fibre content, and the balance, being the short fibre which breaks away during the scutching operations, is classed as tow. Line fibre, which is the main product, is used as a raw material in the manufacture of linen cloths, canvas, fire hose, tenting, cordage, sewing threads and the like.

(*Aust. National Publicity Assn.*)

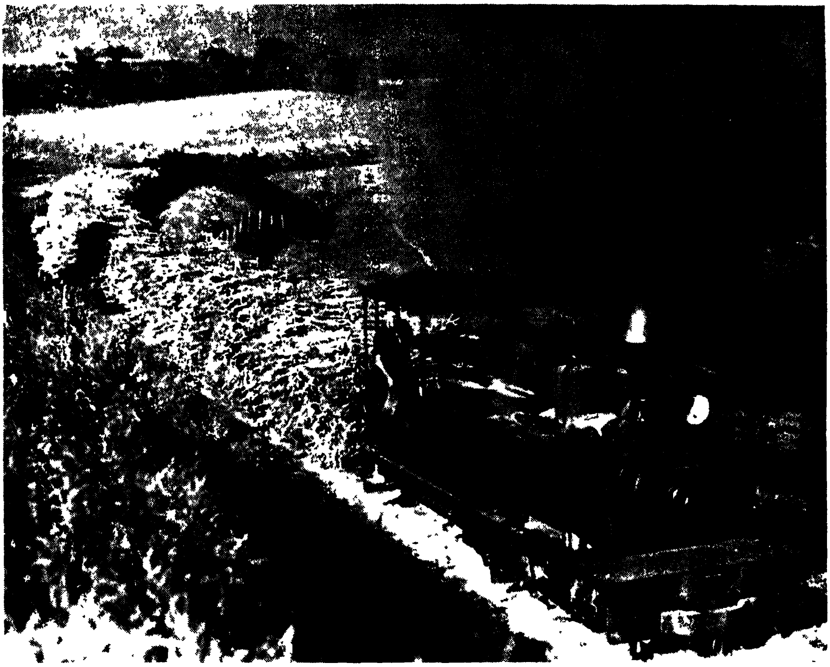
Plate 55. Border Leicester sheep on irrigated lucerne pasture, Shepparton, Vic.

British breeds and their crosses with Merino give best results in fat lamb production.

(*Aust. National Publicity Assn.*)

Plate 56. Cane cutting at Gordonvale, Qld.

Australia is probably the only country where sugar cane cutting is done by white people. Mechanical harvesting of sugar cane is so far not entirely satisfactory.



(*Aust. National Publicity Assn.*)

Plate 57. Cane-tram en route to Gordonvale sugar mill, Qld.

The total length of cane-field tram lines roughly equals the distance between Melbourne and Darwin.

(*Dr. I. Molnar*)

Plate 58. Strip ploughing in a Victorian orchard

The 'Petty' plough specially designed by Petty Bros. of Doncaster, Victoria, for strip ploughing near the trees has been an outstanding invention. It is used widely now throughout Australia for general ploughing in orchards as well as for the work for which it was designed.

(*B. Seppelt & Sons*)

Plate 59. Aerial view of vineyards with winery in the foreground, Seppeltsfield, S.A.

An area favourable for the production of sweet dessert wines. For this type of wine underground cellars are undesirable, because the existing relatively high temperature assists in the maturation of fortified wines. This plant also produces vinegar.

(*Aust. National Publicity Assn.*)

Plate 60. Spreading sultanas on drying racks, Mildura, Vic.

Sultanas are dipped to remove the bloom before they are spread on the wire netting.

(*C'wealth Dept. of Information*)

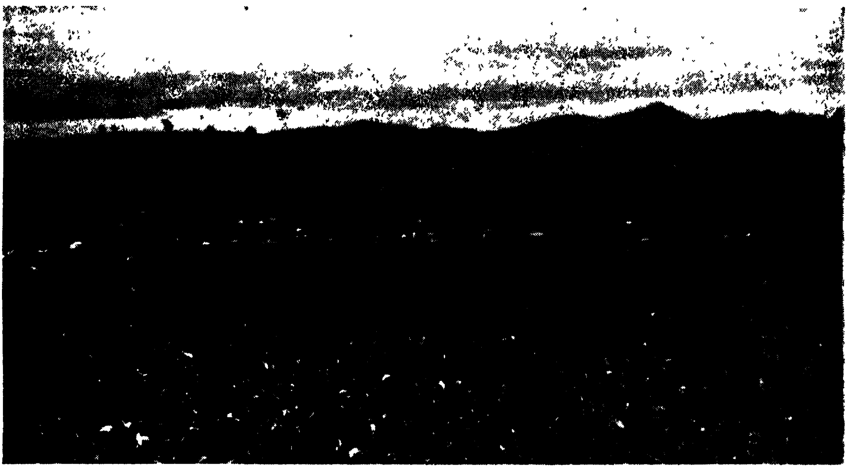
Plate 61. Orange grove under irrigation

(C'wealth Cinema and Photographic Branch)

Plate 62. Pineapple plantation, Queensland

(*Aust. National Publicity Assn.*)

Plate 63. Harvesting oats with reaper and binder, Tasmania



(*Dr. I. Molnar*)

Plate 64. Potato field, north-west coast, Tasmania

Flax Production Committee was established by the Commonwealth. The committee was given full power to direct and control this industry during the war, and arrangements were made for the leasing by the Commonwealth of the whole of the assets and undertaking of the Victorian company.

While the seed for the additional 13,000 acres was still in Britain the committee arranged contracts with farmers for the sowing of this seed in 1940, making in all 12,000 acres in Victoria, 8,000 acres in Tasmania and 1,000 acres in Western Australia, a total of 21,000 acres. The location of

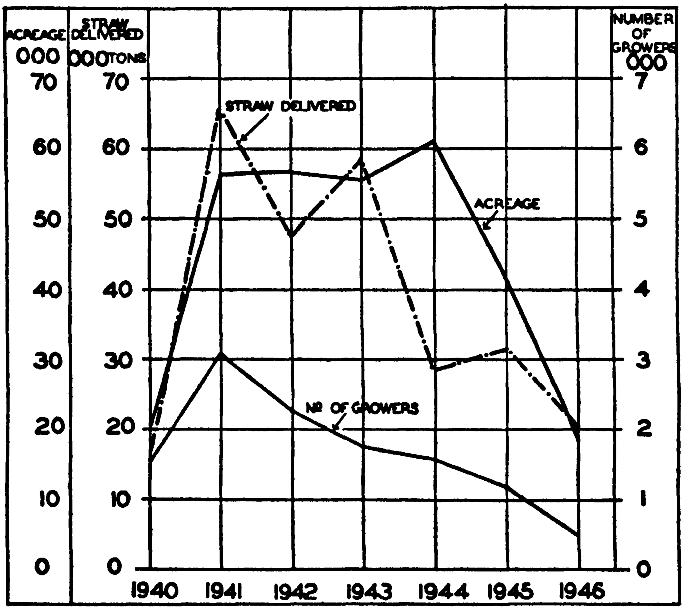


Fig. 68. Development of the Flax Industry

(Based on information kindly supplied by the Flax Production Committee)

the areas within the individual states was chosen as far as possible where attempts had been made in the past to grow flax and where some success could be expected. Suitable climatic conditions were the first consideration, mainly because flax has a relatively wide tolerance to soil conditions. The available rainfall, length of growing season and temperatures were of major importance. The selection of such areas was facilitated by a climatic study of most of the states.[14]

In 1941, the British government asked that up to 50,000 acres be sown on its behalf in Australia during the war years, and in order also to meet Australian requirements the sowing programme during those years was fixed at not less than 60,000 acres per annum. This area was allocated between

14. Forster, H. C., 'The Use of Climatic Graphs in Determining Suitable Areas for Flax Production,' *Jour. of Agric., Vic.*, Vol. xxxix, 1941.

the states of Victoria, South Australia, Western Australia and Tasmania. This expansion was achieved with the assistance of a scale of guaranteed prices fixed according to the quality of the product; further, in view of the uncertainty in the minds of many farmers, in the first years, certain concessions were offered to growers for any acreage planted under contract which was not worth harvesting. The crop was new to most growers and requires careful cultivation and harvesting, with the purchase of new machinery sometimes involved. The prices fixed were not excessive and a tribute is due to those growers who at some risk responded to the appeal to launch out on the new venture. Fig. 68 shows the development of the flax industry from 1940-46.

To process the straw from the 60,000 acres, forty processing units were established. The capital cost involved in machinery and equipment up to 1947 was of the order of £800,000. Nineteen units were established in Victoria, fourteen in Tasmania, four in South Australia and three in Western Australia.

Production Practices and Organization

While in Europe flax is sown in the spring and harvested in the summer, under the uncertain spring rainfall conditions in Australia sowing has to be done in late autumn or early winter, while harvesting takes place in the early summer.

In the main flax producing countries in Europe harvesting has been done by hand-pulling, although pulling machines have been developed in recent years. In Australia no kind of large-scale field crop production can be economic without mechanization, and the need for mechanical harvesting devices was even more necessary during the war when labour was scarce. The crop in Australia is harvested normally by a reaper and binder, a machine in general use for cutting oaten hay, and this machine was found to be satisfactory for flax. The plant must be cut well before it is dead ripe but must be sufficiently mature to complete seed ripening in the stook where the sheaves stand for about ten days after cutting.

During World War II the harvesting and dew retting processes were modified by the introduction of 'dual' harvesting in some districts. This involves the deseeding of flax by a specially adapted header, similar to that used for wheat harvesting; and immediately after this operation the straw is cut either by a special reaper-spreader or a normal reaper and binder. Dual harvesting is illustrated on Plate 66. This overcame the need for the crop to be handled twice in the mills or deseeding depots. Formerly the sheaves had to be deseeded first, then retted, or more frequently put into stacks before retting could start.

Unless the straw is dew retted on the field immediately after being 'dual harvested', it is carted to the mill where the sheaves are deseeded and

then either water retted in tanks or carted to a field near the mill where the straw is spread for dew retting. In the former case bacterial action destroys the gummy substance in the straw, and the fibre layers are then readily freed from the woody core of the stem during the subsequent scutching process; in the latter, the retting is done by fungi on the field. For dew retting the straw was first spread by hand, and about two acres were required for one ton of straw. The straw had to be turned at least once to facilitate fungal action and after the retting was completed it had to be picked up again by hand. The cost involved in these operations was considerable, and mechanization was needed. A spreading machine and a pick-up machine (Plate 67) were developed, but both are in only limited use now. The pick-up machine's role declined with the larger adoption of tank retting, while the spreading machine's role is limited by both tank retting and dual harvesting. Any extension in the use of the spreader would be to the remaining districts where normal dew retting is practised, that is, where the straw, after deseeding, is spread by hand. The period required for dew retting varies greatly with the prevalent moisture conditions, and if they are unfavourable it may take as long as six months, during which time the damage by wind may be considerable. Average dew retting time would be six weeks.

When the Flax Production Committee undertook the direction of the industry, only the mill at Colac in Victoria had facilities for tank retting. Although the hazards associated with dew retting under the unreliable Australian climatic conditions were realized, the Flax Production Committee were not inclined in the early stages to spend the extra sum of about £20,000 per mill on boilers, tanks, and other equipment necessary for tank retting. In any case the dew retting method provided the maximum quantity of fibre in the shortest possible time—an important point under war conditions when building was difficult and the fibre was required with a minimum of delay. Later, however, more mills were equipped with tank retting facilities. In this process the flax straw is placed in specially constructed concrete retting tanks and steeped in warm water at controlled temperatures for periods of from three to five days. When the retted straw is taken from the tanks it is placed in 'gaits' to dry, after which it is processed in the mill. The final process is the separation of the fibre from the woody part of the stem of the plant. A machine known as a scutcher does this by means of a breaking and beating process.

It is uneconomic for the mills to process straw from short crops because of the low percentage recovery of fibre and the low price received for the poor quality fibre produced from such crops. The minimum length of straw purchased for processing into fibre during the period from 1940 to 1945 was 21 inches, although in 1940 and 1941 crops shorter than 21 inches were purchased at a nominal price for the sake of the seed. For the 1946 crop this minimum length was raised to 22 inches and for the 1947 crop to

24 inches. Flax prices are determined each year for standard straw and deductions are made for excess amount of weeds, for short straw, for defects in quality of straw and for bad harvesting. If the straw is better than standard, bonuses are paid. The valuation of the straw is done on the field after the harvest, by employees of the Flax Production Committee, but the grower has the right of appeal to a senior qualified officer of the State Departments of Agriculture. The following table shows the contract prices from 1940-1947.

Contract Price per Ton of Straw

	Standard quality	Maximum price (incl. all bonuses)
1940	£5	£6
1941	£5.15.0	£7.10.0
1942	£6.5.0	£7.10.0
1943	£8.5.0	£10.0.0
1944	£8.5.0	£10.0.0
1945 .. .	£8.5.0	£10.0.0
1946	£7.5.0	£9.10.0
1947	£7.5.0	£10.5.0

In flax growing the greatest risk is the weather, but crop failure may be due to several other factors such as rust, attack by the climbing cutworm (*Heliothis armigera*), wilt, and deficiency of either calcium or trace elements in the soil. Considerable research work was done to devise means of overcoming these troubles.[15]

The following table shows the acreage sown and that from which fibre was accepted by the Flax Production Committee in 1945, 1946 and 1947:

	Acreage Sown			Acreage from which fibre was purchased by the Committee		
	1945	1946	1947	1945	1946	1947
Victoria	26,419	12,041	12,183	13,339	8,936	9,929
South Australia .	6,292	2,599	3,544	4,595	2,225	3,008
Western Australia	3,346	2,940	2,063	1,146	2,098	1,346
Tasmania . . .	5,355	774	—	3,768	528	—
Commonwealth .	41,412	18,354	17,790	22,848	13,787	14,283

Similar tables are not available for other years, but there were seasons when crop failures were worse than in the above three years.

15. Millikan, C. R., '"Withertop" (Calcium Deficiency) Disease in Flax,' *Dept. of Agric., Victoria, Biological Branch, Technical Bulletin*, No. 2, 1944; and by the same author, 'Wilt Disease of Flax, "False" Browning Reaction to Rust Infection in Flax, Damping off Disease of Flax, Iron Deficiency Chlorosis of Flax,' *Jour. of Agric., Vic.*, Vol. XLIII, 1945; Adam, D. B., and Piper, C. S., 'The Use of Zinc for Flax,' *Jour. of Agric., S.A.*, Vol. XLVII, 1944. A rust-resistant variety, 'Wada', developed by the Western Australian Department of Agriculture, is now in its experimental stage.

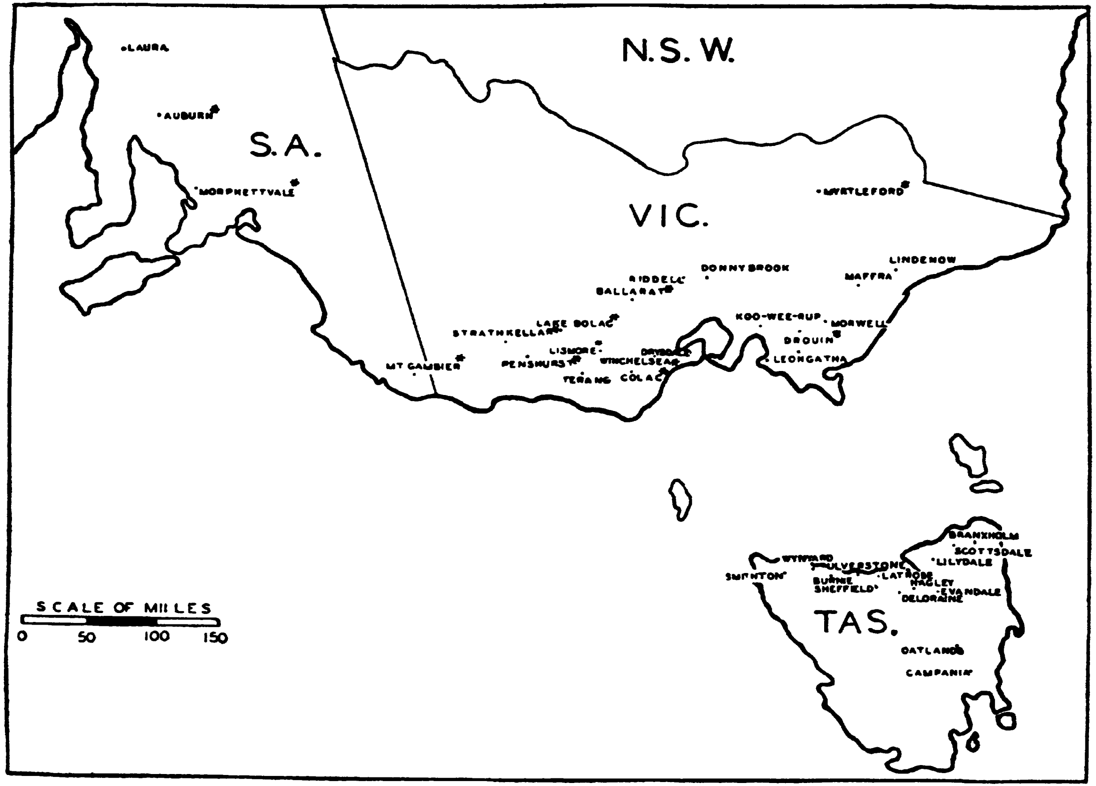


Fig. 69. Location of flax mills and deseeding depots in the south-eastern states

(By courtesy of the Flax Production Committee.) In 1947 the main flax growing areas were around the mills still in operation. These mills are marked by asterisks. Flax production has been discontinued in Tasmania because it proved to be uneconomic.

The forty mills and deseeding stations established in 1941 were so placed that the flax-growing farms were practically all within about twenty miles of the mill. No mill was erected unless contracts with the farmers for the growing of at least 1,500 acres of flax were possible. Deseeding facilities were often made available where smaller areas were involved. Deseeding stations were also established where it was not possible at the time to arrange transport to a full scutching mill or where the spread of a noxious weed from one district to the other had to be avoided. Early in the war, the cost of a dew retting mill was between £7,000 and £8,000 according to its size, whereas that of a deseeding depot cost on the average £3,000. The more recently established mills, especially those equipped for tank retting, have cost much more. The transport of straw from the field is still mainly done by road.

The location of the mills and deseeding stations in the south-eastern states is shown on Fig. 69. Those in Western Australia were established at Yarloop, Beelerup and Boyup-Brook (Fig. 71), but in 1947 only the last of these was still in operation.

The thirteen mills still operating in 1947 are placed in areas which after consultation with the Departments of Agriculture in each flax growing state were considered most suitable for flax growing. Seven of the thirteen mills are tank retting units. The six mills still using the dew retting process lack either water supply or a sufficiently stable flax supply.

The thirteen mills are capable of treating sufficient straw to produce 2,500 to 3,000 tons of fibre, the estimated annual requirement of Australia plus a small margin for export in the years 1946 and 1947. To meet this demand the area approved for flax for each of these two years has been set at 30,000 acres, but, for various reasons, considerably less than this area has been grown.

Economics

The wartime agreement with the British government terminated on 31 October 1946, and up to 30 June 1946 nearly 13,000 tons of line fibre, valued at approximately £3,000,000, had been produced. About two-thirds of this fibre was supplied to the British government and the balance was used in Australia, mainly in the production of goods for the fighting services. The total quantity and value of the various flax products up to 30 June 1947 are shown in the following table.

	Quantity in tons	Value £,000
Line Fibre	14,944	3,303
Flax Tow	20,435	517
Linseed	20,073	565
Flax Chaff and Winnow Refuse[16] ..	18,946	91

16. These by-products are sold as stock foods.

During the war years, when flax fibre had to be produced almost regardless of cost, substantial losses were incurred in the production of flax in Australia. Two-thirds of this loss was borne by the British government and the balance of one-third by the Commonwealth. The cost of production, however, has been steadily reduced, and whilst the costs of handling and processing the straw are now not unreasonable, the cost of production per ton of fibre is still high, on account of the comparatively low average yield per ton of straw treated. The loss of straw, and damage to the fibre in the straw, through high winds and unsuitable weather conditions whilst the straw is spread for dew retting, is the primary cause of the low average yields over the recent years. This position is clearly shown by the much higher yields obtained by the tank retting mills, most of which are now operating at profit.

At the end of World War II it was not clear that the industry was on an economic basis and therefore it was not attractive to private enterprise. On the other hand, although the Commonwealth was anxious to establish the industry permanently in Australia, it was doubtful whether, in the absence of its wartime powers, it had authority under the Constitution to carry on this commercial undertaking. Following on discussions with the state governments concerned, the Commonwealth, with the consent of the states, agreed to continue to direct and control flax production in Australia for a further two years. This trial period covers the sowing and processing of the 1946 and 1947 crops. The processing of these two crops will not be completed until about the end of 1948, and a further decision has to be made as to whether the industry is to be carried on by the Commonwealth, or by the states, or by private enterprise.

In the districts which are suitable for flax production the crop competes with oaten hay, but it requires more care and better machinery and the climatic risk is greater. On farms where oaten hay is not the principle reserve its competitor for the available labour is meadow hay; many of the districts are mainly engaged in sheep raising and dairying. Its ultimate success will depend on the prices of oaten hay, wool, fat lambs and dairy products when compared with flax. There is little doubt that if the world demand for flax continues, the crop has a place in a rotation of, say, five or six years under a mixed farming system in the appropriate district.

Linseed

Before World War II, Australian linseed requirements were largely met by importation from India and the price was not high enough to make linseed production attractive. Numerous attempts were made to grow the linseed variety of flax but with little success, owing to rust, cutworms or unsuitability of soils.

The fibre varieties of flax are uneconomic for seed production. The percentage of seed in the straw delivered to the mills is usually about 5-7 per

cent, with an oil content of about 36 per cent, while true linseed varieties have a content of 40-42 per cent.

Although at the present time proven varieties for Australian conditions are not available, nor is there any certain knowledge as to which areas could give the best results, a strenuous effort is being made in each state to build up stocks of the 'Walsh' variety, a rust-resistant linseed type introduced from U.S.A. The area under this variety in 1947 is expected to be about 1,400 acres. If the prices of linseed from other countries remain high enough, the crop may have future possibilities, either in the fibre areas or in the more reliable parts of the wheat belt.

7. VEGETABLE CROPS

The range of vegetables which can be grown in a continent which has such diversity of climates as Australia is large. Market gardening was an obvious line of activity for some individuals adjacent to the larger cities even in the early days. The large volume of produce grown per acre soon made the application of heavy dressings of manure and fertilizers necessary, practices which were in marked contrast to those characteristic of broad scale farming. Apart from soil poverty, whether inherent or induced, in the districts near the capital cities, the chief problem was that of obtaining sufficient water to supplement the rainfall and keep the crops growing in the dry periods. For this purpose supplies from city water supplies are available but expensive, while the supplies obtainable from rivers are small owing to the scarcity of reliable streams.

The improvement in transport facilities both by rail and road extended the regions from which supplies could be drawn. The development of irrigation both in areas adjacent to the cities and in those which are further removed has made cheaper and more even supplies possible. The usual tendency to lengthen the period in which each type of vegetable is available has been as marked in Australia as in other countries with a complex economy. The higher price which more discriminating buyers are prepared to pay for out-of-season production compensates for the extra costs of transport or of special methods which have to be employed. During the period when supplies of any type can be raised near to the consuming centre the prices received by growers are often very low; on the other hand, when some special circumstance, such as a restriction in the use of water, upsets the normal balance, prices may rise to levels which give very handsome returns to those growers.

The supply of **tomatoes** to Melbourne is an example of the wide geographic range from which vegetables may come. During mid-winter supplies are drawn from the Geraldton district in Western Australia (Fig. 71). The next source of supply is from Rockhampton and the coastal areas of southern Queensland. Later on Adelaide tomatoes appear, and from November and December supplies come from the middle Murray and the

Riverina. The Goulburn irrigation districts near Shepparton (Fig. 70) are producing large quantities in January, while later crops (February to April) are grown near Melbourne itself or in areas of good rainfall near the coast.

Similarly, vegetable **peas** and **beans** may be moved over long distances to supply special markets during limited periods. Bean growers at Orbost in Eastern Gippsland at certain times send their produce by road to Bombala, 102 miles, and thence by rail to Sydney a further 329 miles (Plate 69). In Western Australia, Perth obtains winter supplies of beans from Carnarvon (lat. 25° S.), a distance of about 600 miles; in this case transport is by ship.

Normally, the expansion of the industry has been dependent on the profit to the growers, and little attempt has been made to rationalize production or equate supply with demand; nor would such a procedure necessarily be desirable in view of lack of stability in regions of supply owing to the production in new districts. This is not true of **onions**, in which Victoria is the state of chief production and where on the volcanic ash soils of the Western District the crop grows to perfection, and is of good enough quality to store well. Long experience showed that when the crop was heavy the price was too low to be profitable. In 1935 an Onion Marketing Board was set up by the Victorian government to regulate the marketing position. The cost of maintaining the necessary regulating staff to cope with the task of preventing evasion made it difficult for this body to show better returns to growers than they would have obtained without any regulations. The Board was naturally in no position to dispose of the whole crop at high prices in a year when supplies were plentiful.

During the war of 1939-45 the extra demand for vegetables for the Australian and Allied Forces in this country and in the neighbouring islands raised an acute problem. It was impracticable to transport the fresh product over long distances along the already congested rail routes, nor were refrigerated cars available. Consequently, numerous new supply centres had to be arranged in the more remote regions, e.g., the Adelaide River and other places in the Northern Territory, and at Ayr in Queensland. It was also realized that the production of canned and dried vegetables would have to be increased. New machinery was obtained from the United States for the cultivation and harvesting of raw crops and also for the factory side of the enterprise; experts were brought over to assist in its operation. Meanwhile farmers were encouraged to cultivate the raw product by a series of attractive contract prices. As a result vegetable production increased considerably. In the early stages of the war, **blue peas** which had always been grown commercially in Tasmania (Plate 68), were used extensively by the Forces because their production could be expanded rapidly and fill the gap until the drying and canning plants were installed. The acerage under this crop reached 44,616 in the season 1943/44, over three-quarters of this acreage being sown in Tasmania.

The following table sets out the acreage and production of vegetables in 1944/45 when the demand was at its height.

Type of Vegetable	Area	Production
	Acres	Tons
Beans, French[a]	20,278	16,533
Beans, Navy	12,755	2,645
Beetroot	4,687	27,674
Cabbages and Brussel Sprouts	13,487	136,937
Carrots	12,740	83,576
Cauliflowers	6,938	79,765
Cucumbers	3,471	5,637
Lettuces	4,825	16,242
Marrows and Squashes	1,864	7,692
Onions	11,888	66,512
Parsnips	2,256	15,598
Peas, Green	74,581	37,928
Potatoes, Sweet	2,453	7,756
Pumpkins	38,451	84,812
Spinach and Silver Beet	850	11,294
Sweet Corn	2,263	4,655
Tomatoes	25,642	113,950
Turnips, Swede	12,889	47,047
Turnips, White	1,444	6,169
Other Vegetables[b]	11,163	—
	264,925	—

(a) Includes beans harvested dry.
(b) Excluding potatoes and blue peas.
Source: *Report on the progress of Agricultural Production in Australia,* January 1947 (Bureau of Agricultural Economics, mimeographed publication).

With the end of the war and the progress of demobilization the need for such extensive production declined and the contract system ceased.

The results of this wartime expansion of vegetable growing have been first to turn the attention of many farmers and horticulturists to the possibility of growing these crops in new locations (Plate 70); and secondly, to establish the vegetable canning industry on a much larger basis than previously. Doubtless, some types will remain as regular crops, e.g. navy beans, which were formerly imported.

How far the canners will manage to retain a hold on the local market remains to be seen, but price and quality are presumably the most important considerations. During the recent war thirty major vegetable dehydrating factories were established, but by 1947 only four were in operation, the others having been dismantled. Outback areas without any facilities for maintaining small garden areas may provide some market for these plants, but many of the stations in the north are situated in places where small water supplies are available and vegetables can be readily grown for local requirements.

CHAPTER XIII

IRRIGATION

1. History of the Development of Irrigation in Australia
2. Present Position
3. Technical Difficulties
4. Future Developments
5. Economic Considerations

CHAPTER XIII

IRRIGATION

1. HISTORY OF THE DEVELOPMENT OF IRRIGATION IN AUSTRALIA (See Figs. 67, 70, 71)

AS already mentioned in chapter II, the seasonal occurrence, in most of Australia, of long periods with little rain emphasized the need for storing water both for domestic and farm purposes. As a result, not only the capital cities, but also some of the centres of population associated with gold mining, had developed water supply schemes by the 'sixties.

On the farms themselves, many of the early settlers, who were fortunate enough to be located beside the infrequent streams, constructed weirs and dams from which water was diverted on to the adjacent alluvial flats, with great improvement of the carrying capacity of the country during dry periods. The idea that such a procedure might be applied on a large scale did not require much imagination, since it had been familiar for centuries in Mesopotamia and Egypt. During the 'seventies the government of Victoria called for reports on the possibilities of water conservation in the northern districts of the state. Acts were passed in the early 'eighties making provision for the construction of irrigation works, and as a result a large number of irrigation 'trusts' were set up in Victoria. Unfortunately, many of the schemes were formulated on an unsound basis, and dealt with country which was not entirely suitable for irrigation. Further, the bodies administering many of these trusts proved incapable of enforcing payment of the necessary dues in years when adequate rainfall made irrigation less necessary. Consequently, most of the schemes ultimately became insolvent.

The progress of irrigation in Australia was greatly assisted by Alfred Deakin, who, by his energy and writings, convinced the public that there were great possibilities in irrigation farming in the Commonwealth. He also visited irrigation districts in other parts of the world, in order to form his judgment as to the correct methods of procedure. At his invitation, the brothers George and W. B. Chaffey came to Australia from California to select land suitable for irrigation. The Chaffeys were responsible for the inauguration of the settlements at Renmark, in South Australia, and at Mildura in Victoria. Grants of land were made to them on the condition that they expended considerable sums of money over a period of years in the establishment of irrigation projects at these two centres. Unfortunately, the financial crisis, which ended in the bank crash of 1893, occurred at the very time when much money had been spent on these settlements, and returns had scarcely begun. Progress was therefore delayed until prices rose at the beginning of the new century.

In 1905 the Victorian government passed a Water Act which abolished all the irrigation trusts except that at Mildura, took over their liabilities, and placed the whole organization of rural water supplies under a State Rivers and Water Supply Commission. The same Act restored to the Crown the beds and banks of all streams in the state. This remarkable piece of legislation avoided, once and for all, every question as to riparian rights and the ownership of water.

The need for co-ordinated action between New South Wales, Victoria and South Australia in respect to the use of the water of the River Murray was early recognized. As a result of a number of conferences from 1902 to 1914, agreement was finally achieved. It was decided to construct a series of weirs and locks on the Murray to retain water for irrigation at various points and to ensure the navigability of the river. It was also agreed to transform Lake Victoria into a reservoir which could be used to ensure a flow into South Australia.

Meanwhile the Victorian and South Australian water authorities pushed on with various schemes. In Victoria the largest of these was dependent upon supplies from the Goulburn River, but both states developed numerous schemes on the Murray itself, some of which required the installation of pumping plants, while others obtained gravitational supplies diverted from weirs on the river. In the period 1912-23 the government of New South Wales opened the Murrumbidgee area with the gradual completion of the extensive works of the Burrinjuck Dam and its dependent channels. The Wyangala Dam, on the Lachlan, was completed in 1935. The Hume Reservoir, the largest work on the Murray, and the key to its irrigation works was completed in 1936 and receives water for many months in the year from its mountainous catchment (Plate 72).

In Western Australia, the goldfields water supply scheme, which takes water in pipes from Mundaring Weir, near Perth, to Kalgoorlie through 346 miles of steel main, was completed in 1903. Since the completion of the original works, many hundreds of miles of branch and reticulation mains have been laid to mining districts, towns, and farming lands within economic distance of the main conduit. The most important extension was laid in 1937 from Coolgardie to Norseman—a distance of 101 miles. Although the costs are too great for the water to be used for irrigation, the success of the schemes attracted public attention to the possibility of impounding and using water. Western Australia lacks large rivers, except in the far north, and the utmost which could be attempted was the construction of numerous small reservoirs to serve limited irrigation areas on the narrow coastal plain, along the south-west railway line from 70 to 116 miles from Perth. The first of these, the Harvey Scheme, was completed in 1917. It was extended in 1930, and other schemes have been developed on the Drakesbrook and Collie Rivers and on Samson Brook.

In Queensland, irrigation has mostly developed by the installation of numerous individual pumping plants drawing water from alluvial gravels. About thirty-six thousand acres of sugar cane near Ayr and twenty thousand acres of crops on the dairy farms in the Lockyer Valley are supplied by this method.[1] A large project was surveyed in the Dawson Valley for cotton farming and dairying, and an initial settlement made in 1927. The Moura Weir has recently been completed, and a small weir has been constructed at Bingera on the Burnett.

Moreover, in different parts of these states and in Tasmania numerous private schemes, covering limited areas, have been developed by the initiative of individuals or groups of landowners in various districts.

2. PRESENT POSITION

Apart from vines and tree fruits, the acreage under irrigation devoted to various crops differs somewhat from year to year, due largely to the climate and vagaries of the season (Fig. 14). During a dry spring a considerable acreage of wheat may be given a single watering; summer cereals are always irrigated. Lucerne and the perennial types of mixed pasture account for a considerable portion of the area in some districts; in others, where water is less abundant, pastures may be mostly of the autumn-winter-spring type composed of annual species. The increase of vegetable culture in some of the irrigation areas has been remarkable, and in appropriate localities early crops of peas and rock-melons are now grown for distant city markets, while tomatoes have become an important crop for some of the canneries. Dairying has made great progress in some districts in which the application of modern pasture knowledge has resulted in the development of some of the most productive land in Australia. Fat lamb production is prevalent; many of the more progressive settlers aim to have a range of pasture types on their properties from which they are able to produce in succession succulent growth for their flocks almost throughout the year.

Although irrigation areas usually manage to absorb a considerable number of stock from the surrounding districts during a dry season, it would be untrue to suggest that irrigation has largely mitigated the effects of droughts in the adjacent districts. So far no definite attempt has been made to organize irrigation districts for this purpose. The dry-land farmer himself does not usually understand irrigation and is not, therefore, well-equipped to run an irrigation property unless, as sometimes happens, he has sufficient enterprise to make it a specific part of his business. At first glance it should be practicable to set up irrigation farms with the objective of accumulating fodder reserves against dry periods in surrounding areas. In fact, the farmer in an irrigation district is not in any better position to produce cereal hay more cheaply than his counterpart in any of the well-established hay-growing

1. Bell, A. F., 'Some Administrative Aspects of Irrigation,' *Cane Growers' Quarterly Bulletin*, Vol. xi, No. 1, 1947.

districts. The price for hay fluctuates widely according to the season, and after a couple of good years, when accumulated stocks are large, prices are correspondingly low. There is no consistent shortage of such hay. It follows that there is no merit in growing hay on an irrigation area unless it is so near the prospective points of consumption as to give it an economic advantage. It might prove possible to work out some scheme whereby livestock owners in the more risky districts would normally have a liaison with some irrigation farm, but until that happens there is little hope of decreasing significantly the losses which occur in the outback areas during droughts. Under existing conditions the irrigation farmer is not personally concerned with what happens to his drought-stricken colleague—his attitude is governed by the price at which he can buy stock for his property.

State	River or Stream	Storage	Capacity in thousands of acre feet
New South Wales ..	Lachlan	Wyangala dam	303
	Murrumbidgee	Burrinjuck dam	771
New South Wales, Victoria and South Australia	Murray	Hume reservoir	1,250
		Yarrawonga weir	95
		Torrumbarry weir	29
		Euston weir	31
		Mildura weir	29
		Wentworth weir	38
South Australia ..	Murray	Lake Victoria	552
Victoria	Murray	Kow-Swamp reservoir	40
	Goulburn	Eildon reservoir	306
		Goulburn weir	21
		Waranga reservoir	333
	Campaspe	Eppalock reservoir	1
	Coliban	Coliban storages	59
	Loddon	Laanecoorie reservoir	7
	Wimmera, Mackenzie, Little Wimmera	Wimmera storages	197
	Werribee	Pyke's Creek reservoir	21
		Melton reservoir	19
	Macallister	Glenmaggie reservoir	105
Queensland	Dawson	Moura weir	5
	Burnett	Bingera reservoir	4
Western Australia ..	Harvey	Harvey weir	8
		Stirling reservoir	44
	Drakesbrook	Drakesbrook reservoir	2
	Samson Brook	Samson reservoir	7
	Collie	Wellington reservoir	28

The table on p. 298 shows the names of the dams or weirs at present constructed for storing irrigation water, the rivers which they impound, and the approximate capacity of the storages. The locations are shown on Figs. 52, 67, 70 and 71.

Stock and Domestic Water Supply

Each of the storages in this table provides irrigation water and also stock and domestic supplies for farms. In some cases the latter function is the more important; this is particularly true for the Wimmera storages in Victoria, where most of the water is used for the gravitational stock and domestic supply of the Mallee and Wimmera already referred to on p. 163. Other rivers have been impounded for the latter purpose, and some large schemes of distribution have been installed. South Australia has several, the largest being that on the Todd River in Eyre Peninsula, mentioned on p. 159. In Western Australia, the extension of the goldfields supply scheme has been referred to on pages 155, 296. Somewhat similar are the supplies drawn from artesian bores in Queensland and New South Wales, many of which are operated on a district basis.

Without such schemes the farm lands they serve would have great difficulty in carrying livestock and the towns in the areas concerned would be far less satisfactory as centres of population. However, the cost of operating such schemes is far too high to use the water for irrigation purposes beyond those of gardens. The farms are rated on an acreage basis for a minimum supply; excess is charged at from 1s. 6d. to 4s. per 1,000 gallons, which is the equivalent of £20 to £50 per acre foot. Manifestly, irrigators cannot expect to meet such charges under normal circumstances.

Irrigation Systems

The map shown on Fig. 70 gives the geographical position of the various water conservation schemes which have been installed or are approved for immediate construction in the south-eastern part of the continent.

In northern *New South Wales* the Keepit Dam on the Namoi, the Glenbawn Dam on the Hunter, and the Burrendong Dam on the Macquarie River, are being constructed to conserve irrigation water. On the Lachlan, which has a very poor catchment, the Wyangala Dam maintains the flow in that river, and also supplies small quantities to the Jemalong district (No. 1), while the Burrinjuck holds the water for the intensive irrigation of the Murrumbidgee Irrigation Areas (No. 2) around Leeton and Griffith, where the main crops are stone fruits, oranges, citrus, rice and vegetables. Excess water from these is supplied to the further districts of Benerembah and Wah-Wah. Number 3 is the small scheme centred on Hay, which is dependent on low-level pumping. North of the Murray is the Berriquin district (No. 4), chiefly concerned with pasture irrigation on properties which have varying water rights, usually about one acre foot of water to ten acres

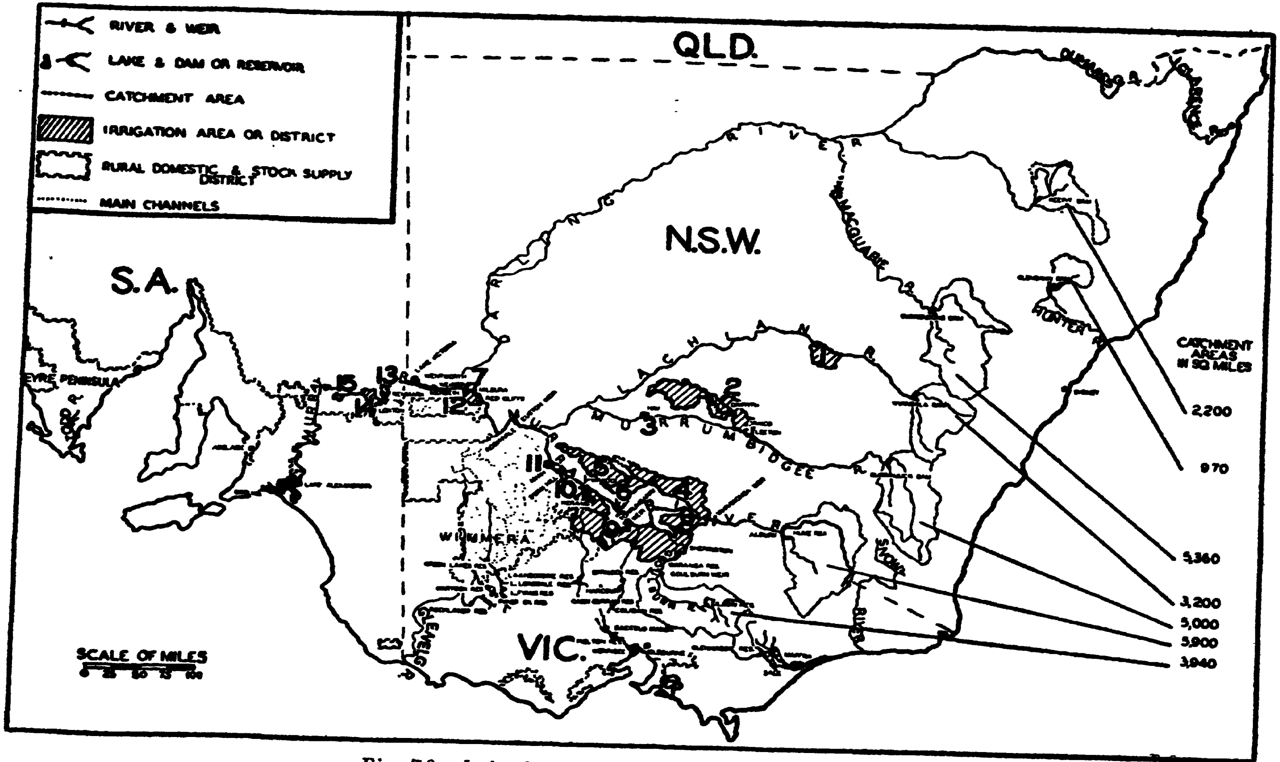


Fig. 70. Irrigation Systems in south-eastern Australia

(Keepit, Glenbawn and Burrendong dams in New South Wales and the Rocklands reservoir in Victoria are under construction.)

1. Jemalong Irrigation District. 2. Murrumbidgee Irrigation Area and, west of it, Benerembah and Wah-Wah Irrigation Districts. 3. Hay Irrigation Area. 4. Berriquin Irrigation District. 5. Wakool Irrigation District. 6. Deniboota Irrigation District and, north of it, Denimein Irrigation District. 7. Curlwaa and Coomealla Irrigation Areas. 8. 'Murray Valley' Irrigation District. 9. Goulburn System. 10. Torrumbarry System. 11. Nyah Irrigation District. 12. Mildura, Merbein and Red Cliffs Irrigation Districts. 13. Renmark and Chaffey Irrigation Areas. 14. Berri and Cobdogla Irrigation Areas. 15. Waikerie Irrigation Area.

of land, although in most seasons excess water equal to double the amount can be bought. The Wakool district (No. 5) is a recent development; it has heavier soils and is mainly used for irrigating pasturage, although some rice was grown on it during the war. The Deniboota district (No. 6) is also new. North of this is the Denimein area, not yet fully developed for irrigation. Farther down the river on the New South Wales side are two small areas (No. 7), Curlwaa and Coomealla. These are pumped schemes, the water being used for citrus and vine production.

On the *Victorian* side is the new 'Murray Valley' irrigation district (No. 8), part of which is being used for stone fruits, but the larger portion for dairying, or raising fat lambs. The water allocation is mainly on a basis of one acre foot to four acres, frequently with opportunity to purchase excess water up to one-third of the primary right. Similar distribution also occurs in those parts of the Goulburn Valley System (No. 9) where pasturage and dairying are the objectives; other parts of this system have a 'one in one' water right and are mainly used for dairying, and for the production of pears, peaches, apricots, some citrus and vegetables. Region No. 10 is supplied from the Murray, from which water is diverted by the Torrumbarry Weir into a series of channels and lakes whence it flows to the districts of Kerang and Swan Hill, in which pasturage is used for sheep and for dairying, and citrus and vines are also grown. The smaller settlement at Nyah (No. 11) obtains its water by pumping and uses it mainly for vine fruits. Area No. 12 includes the Mildura, Merbein and Red Cliffs settlements, where the water has to be pumped to considerable heights (105 feet at Red Cliffs) and is correspondingly expensive; production is, therefore, mainly confined to such crops as vine fruits, citrus and vegetables. Similar conditions apply to the small scheme at Robinvale now being constructed.

Smaller Victorian schemes occur on many rivers—the Eppalock, Coliban and Laanecoorie reservoirs on small streams north of the ranges provide water for a variety of uses, the most notable area being the apple-growing district of Harcourt. Wartook Reservoir and other lakes in the Southern Wimmera are the bases of the Wimmera-Mallee gravitational supply scheme (shown in detail on Fig. 52) which will shortly be enlarged by the additional water south of the Great Divide brought round the ranges from the Rocklands reservoir now under construction: only small quantities of this water are available for irrigation. Pyke's Creek and Melton reservoirs provide supplies for Bacchus Marsh and Werribee settlements, which are devoted to dairying and fruit and vegetable production. In Gippsland, the Glenmaggie Weir on the Macallister River holds the water for the Maffra-Sale area, which is mainly devoted to general pasturage and dairying and cultivation of vegetables and sugar beet.

In *South Australia* irrigation settlements are confined to the Murray. The chief of these are Renmark and Chaffey (No. 13), Berri, Cobdogla

(No. 14), and Waikerie (No. 15). An irrigation scheme near Loxton on the Murray has been commenced. Lake Alexandrina at the mouth of the river has interesting possibilities. Originally, it was saline owing to periodic incursions from the sea through the river mouth. Now that a barrage has been placed across the opening at Goolwa the salinity has fallen rapidly and in years to come a pumped irrigation scheme may be practicable; unfortunately, the soils which would be thus commanded are not attractive.

In *Western Australia* (Fig. 71) the three irrigation areas are the Waroona, Harvey and Collie, representing seventy-six thousand acres. On these the demand for more frequent waterings due to pasture improvement resulted in the gradual increase in water storages. The amount of water made available per farm varies in the districts; in some every acre has a 'right', in others only a third of each holding is in this position. Normally 1½ acre feet of water are available for each acre with a water right.

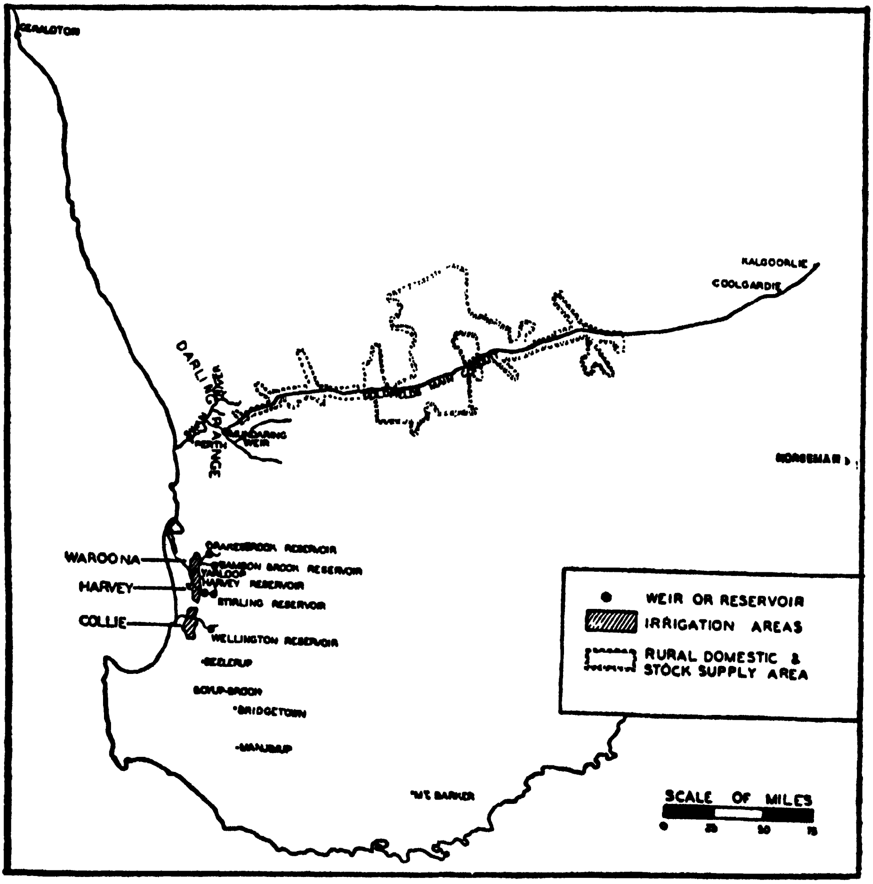


Fig. 71. Irrigation Systems in Western Australia

3. TECHNICAL DIFFICULTIES

This account of irrigation development might encourage the view that irrigation is a simple process, that all it requires is the mere application of water to the land, or that its results would stimulate all land-owners to clamour for irrigation whenever it is possible for a supply to be arranged. In fact, none of these ideas is wholly correct.

Farmers who thought that when irrigation water was applied to a pasture in a district of dry climate it would automatically give a great increase in growth found that they were wrong. They gradually learned that, if the water is to be used effectively, an entirely new set of pasture plants must be introduced. These new species have different growth characteristics which enable them to respond to the change in habitat brought about by irrigation. Further, although land may seem flat enough to the eye, it usually proves far too uneven to give adequate distribution of water. Paddocks which are to be irrigated must be ploughed up and graded, otherwise some spots will not be covered and 'ponding' will occur on other patches—with disadvantageous changes to both. These alterations in the farms and their systems mean considerable effort and expense, which some farmers are either unwilling or unable to undertake.

All soils do not lend themselves equally well to irrigation. Sandy types are sometimes too permeable and let too much water pass through at the top end of a run before any reaches the lower end. Clay soils, on the other hand, are often extremely impermeable to water; on such it is difficult to get the water to penetrate deeply enough to enable the plants to grow. Further, some of the areas have saline layers in their sub-soils at no great depth; and, if excess water is applied, the salts may rise to the surface if the operation is not done carefully. In Victoria, in the middle Murray region, large areas of irrigation land were temporarily ruined in this way. Appropriate techniques for reclamation have been worked out and applied in some cases, but salted areas are still frequent. Similarly, in the Mildura district a considerable number of blocks became salted and were only reclaimed by an expensive system of underground drainage (see p. 247). These disasters, which resulted in great financial losses, have taught the lesson that irrigation schemes should only be planned for a district after a detailed soil survey has been made of the land which is to be irrigated.[2]

In the early days farmers were often unaware of the most advantageous use to which the irrigated land could be put. Settlers tried this or that crop, and in course of time found out the particular kinds of soils which favoured each type of production. The cruder errors were discovered fairly soon, but

2. The following *C.S.I.R. Bulletins* dealing with soil surveys in irrigation areas have been published: 42 and 56 (Renmark), 45 (Swan Hill), 51 (Lower Murray), 62 (Cadell), 73 (Tresco, etc.), 86 (Berri, etc.), 107 (Coomealla), 118 (Murrumbidgee I.A.), 123 (Merbein), 125 (Kerang), 133 (Mildura), 137 (Red Cliffs), 141 (Waikerie), 152 (Cobram, etc.), 162 (Wakool), 189 (Berriquin).

it has taken some time to show that some soils were not really well suited to certain crops, while other land in the same district was very successful. For instance, in the Goulburn Valley in Victoria experience showed that some of the stone fruits when planted on heavier soil types died back shortly after reaching maturity, while on others their life seemed to be much longer; on the other hand, pears did very well on the heavier soils. In citrus trees the relation between soil type and success has been evident; in recent years citrus growers have requested that new plantations should only be permitted on the most suitable soils in order that the new groves would have high yields and therefore low costs of production. They were aware that, in the event of plantings being made on incorrect soil types, their owners would have high costs and would therefore demand higher market prices than should be necessary. The well-established orchardists knew from experience that high prices nearly always mean decreased consumption.

The technique of applying the water was gradually mastered, and it is now generally understood that for each soil type there is an optimum 'length of run' of water in each irrigation paddock or orchard. The rate of application of the water is also important. Each farmer has to learn the characteristics of his own soils. Spray irrigation may solve these problems in certain areas, but it is too early to suggest that the possibilities of its adoption are clear.

For a time during the 1920's it was seriously doubted whether irrigation would solve the problems associated with low rainfall, but the work of the last twenty years has been encouraging and today, wherever the problems of irrigation have been fully mastered and irrigation has proved successful, there is a demand for more water conservation in the hope that its benefits will be more widely spread.

This does not mean that, in some irrigable districts, the older farmers are easily convinced that they will be better off with the more stable systems of agriculture which can be developed as a result of irrigation. Nor is it correct to assume that appropriate techniques have yet been developed for irrigating the heavier soil types. Investigations on specific problems are in progress at a number of centres, and the successes so far achieved indicate that further advances will be made in the future. So far all these investigations have been in the southern districts; and, in the event of large-scale irrigation projects being developed in the tropical areas of Australia, a new range of problems will have to be elucidated before the results can be predicted with confidence. So far the only attempt in this direction has been a preliminary small-scale station on the Ord River in the Kimberleys (Fig. 59), although the vegetable farms run by the Army in the Northern Territory during the war period are of interest.

One of the difficulties always encountered in the development of efficient techniques for irrigation is the time which elapses before farmers in

a new area realize that irrigation is a complicated process. The same mistakes have been made in most of the irrigation districts in each state. It is clear that, in addition to the preparation of soil maps in each new area on to which water is to be led, an advisory service should be established before the supply is actually forthcoming. If this is not done, many mistakes are bound to be made, and the result will be disappointment and disillusionment. In the past there has been a lack of effective trained personnel for this work, but it is to be hoped that this situation will alter. Naturally, if the farmer starts off with the idea that irrigation water is going to compensate for deficiencies in rainfall, and so solve all his problems, he does not necessarily realize that irrigation requires considerable knowledge and a clear understanding of its dangers as well as of its benefits.

4. FUTURE DEVELOPMENTS

The increasing successes of irrigation settlements in recent years, coupled with the periodical recurrence of droughts with their attendant losses in dry farming regions, gradually made the Australian public more conscious of the need for increasing the number and size of irrigation schemes wherever practicable. Uninformed people are apt to think that in irrigation lies the secret of the future intensification of production in the dry centre of Australia. This, however, is but an idle dream, because even if all the available water was accumulated and devoted to irrigation purposes the total area which could be supplied would only be a minute proportion of the total land surface. On the other hand, it is now abundantly clear that in the better utilization of available water lies a very potent method of increasing the efficiency of production in many regions.

In *New South Wales* it is unfortunate that the catchments of many of the rivers are not large or well watered, and in some cases the rivers themselves run in gorges which are not very suitable for impounding large quantities of water. In addition to those mentioned on pp. 299 *et seq.*, large schemes have been put forward for dealing with the Snowy and Clarence Rivers. The former scheme is particularly interesting in view of the fact that it involves diverting water by long tunnels through the mountain ranges either into the Murrumbidgee or the Murray. Great argument has ensued as to which of these courses should be adopted. It seems certain that the water impounded could be profitably used in either river system, but it is held that far greater supplies of electric power could be generated in the event of the diversion being made to the Murray. The Clarence scheme also has the capacity for developing electric power and, from the irrigation point of view, its waters would be of value in stabilizing the farming production in the lower part of the valley.

In this state there are other possibilities of improving the control of the rivers so as to utilize a greater proportion of the total water which they

deliver. For instance, it would be practicable to put further controls on the Murrumbidgee and some of its tributaries and thereby raise the proportion of the water conserved above the 40 per cent now harnessed. Similar proposals are made with regard to the Murray itself. Naturally such developments must increase the capital cost per acre foot conserved.

In *Victoria,* most of the more effective streams have now been utilized to some extent for irrigation purposes, but recently a proposal has been made to increase the Goulburn storages by a great enlargement of the Eildon reservoir to 2,350,000 acre feet, which will mean that about 80 per cent of the average flow of the river will be used. The Denison-Nambrok scheme which lies to the west of the Maffra-Sale area, the Cairn Curran reservoir (120,000 ac. ft.) on the Loddon, and the enlargement of the Eppalock storage to about 100,000 acre feet, have all been approved. In addition, other small schemes will be practicable on some of the minor rivers and will be helpful for small districts or for farmers whose properties lie along their courses.

In *South Australia,* as already stated, the available river capacity is fully utilized, except for such additional areas as can be supplied from the Murray when that river is further controlled.

In *Western Australia* the rivers of the south-western division can only be further utilized to a small extent, and the volume of water which they contribute will never be large enough to permit the development of any very large schemes. A proposal to raise the Wellington Dam on the Collie River, thereby increasing the storage capacity from 25,000 to 35,770 acre feet, is under consideration. In the middle section of this state spear wells have been sunk into the river sands of the Gascoyne near Carnarvon (lat. 25° S.) for providing water for banana plantations, a method which may be adopted on the other intermittent streams in this region.

In *Queensland,* the control of waters presents the typical problem associated with a sporadic rainfall consisting of very heavy downfalls. Schemes are being considered for the Dumaresq River and for the Burdekin, the only Pacific river with a large catchment area. The narrow width of the coastal plain and the undulating nature of much of its terrain suggests that, if the water is to be used on the coastal side of the ranges, development will take the form of numerous small schemes rather than of a few large ones. The late Dr. Bradfield put forward an ambitious proposal[3] to connect the head waters of several of the rivers and pass them by tunnels and conduits through the ranges to the dry lands of the interior. More detailed examination of his plan has shown that the levels of the country do not permit of its

3. Bradfield, Dr. J. J. C., 'The amplification of Queensland's water resources,' article in *Civil Engineering,* February 1939, and by the same author, 'Watering Inland Australia,' article in *Rydge's* (Sydney publication), October 1941.

fulfilment, and that he greatly over-estimated the water flow in many of these rivers.[4]

Of the rivers which flow on the inside of the ranges, those which find their way towards the central Australian basin are intermittent (Fig. 34). In some years their flows are copious enough to produce flooding over wide areas; in others, the flow is a trickle or disappears altogether. The country of the lower river valleys is very flat, and individual streams break up into an interwoven, complex system of channels. The problem of regulating the flow in streams of this type is a difficult one, and it is not yet demonstrated that the project would be of great value. It is true that it might be possible to regulate production through the development of stabilized farming areas in parts of these regions. On the other hand, the excellent growth of grazing plants which is now obtained over considerable areas in a flood year would be lost. Further, it is not clear whether the beef industry, which is at present the main form of production, would stand the somewhat costly processes of conserving and subsequently feeding out the fodders to the herds.

In the broad expanses of the Northern Territory, the Kimberleys and north-west Queensland, are numerous large rivers, most of which are intermittent. On some of these it seems certain that irrigation schemes could be developed. A proposal for using the waters of the Ord River, which reaches the sea near Wyndham, has been worked out in detail from the engineering point of view (Fig. 59). As already suggested, this and other schemes will require the development of new systems of agriculture, new irrigation techniques, and possibly new races of cultivated plants. The particular type of climate which characterizes this region is not found in many other parts of the world where irrigation is practised. The agricultural scientists of Australia will have a fairly heavy task if they are to ensure effective development, particularly in devising agricultural systems which can be operated effectively by mechanized methods through which alone a reasonable standard of living can be afforded to the workers. It seems that the development of types of farming aimed at increasing the efficiency of the beef industry has greater promise. Other tropical crops, however, may have possibilities.

One further warning regarding all expansion of irrigation should be given. Some of the most notable successes have been the result of the development of types of production which cannot be carried out efficiently in Australia except under irrigated conditions. Dried and canned stone fruits are examples; both these industries largely depend on export markets, and there is no certainty that a further expansion might not lead to over-production and a fall in price to levels which are below reasonable costs. Such a fall occurred for a time during the inter-war period. It seems that further development of irrigation should aim at stabilizing production on the

4. Nimmo, W. H. R., 'Results of investigation of Bradfield's Water-Irrigation Plan,' *The Commonwealth Engineer*, Vol. 34, No. 11, 1947.

dry farming areas. To some extent this has already been achieved in the fat lamb and dairying industries. The greater the development of irrigation in proportion to local population, the more necessary would it be to stress this aspect of the use of conserved water.

5. ECONOMIC CONSIDERATIONS

From the haphazard development of irrigation in Australia, and from the lack of attention given to the technical details and training of irrigators in the past, it is not surprising to find that, in many cases, the economic results have been disastrous. All the state authorities dealing with irrigation on the grand scale have been compelled to acknowledge severe losses at some stage of their operations. The State Rivers and Water Supply Commission (Victoria) started by shouldering many of the debts which had been incurred by the private irrigation trusts. They also took over certain derelict schemes which had proved a considerable burden. Much of the later work, although technically more successful, was financially unsatisfactory if looked at solely from the standpoint of interest-earning capacity. The actual amounts of capital transferred to the general debt by the states are somewhat difficult to assess in view of the fact that part of the sums concerned took the form of advances to settlers, and also because some of the schemes were not solely designed for irrigation, but were meant to supply water for other purposes also. The whole matter was reviewed at length by F. W. Eggleston in 1932.[5] In 1936 a Royal Commission investigated the position of the irrigation schemes in Victoria,[6] and subsequently to this the state government transferred to the 'Capital expenditure borne by the State account' loans for works for irrigation and domestic supplies amounting to £26,345,536 at 30 June 1946.[7] The various irrigation districts in Victoria are therefore required to pay operation, maintenance and depreciation charges only. The losses on land settlement in irrigation areas in Victoria are merged with those of other land settlements. In New South Wales the apportionment of overhead costs between the state and the irrigation authorities is on similar lines.

In Queensland, the Land Administration Board acted as a Royal Commission to consider the Dawson Valley Irrigation Settlement.[8] In their report the following statements were made:

> The capital cost of the Dawson Valley Irrigation Scheme has been enormous for the small settlement results obtained. It must be regarded as the most expensive settlement project in Queensland's history. . . .
>
> The total outlay on the Irrigation Settlement Scheme was £1,053,057, or an average of £8,492 per settler for each settler so far established. . . .

5. Eggleston, F. W., *State Socialism in Victoria* (King).
6. Three progress reports of the *Royal Commission on Expediency of Amending the Water Act, 1928, and Other Matters*, 1936 (Govt. Printer, Melbourne).
7. *State Rivers and Water Supply Commission Annual Report*, 1945-46 (Govt. Printer, Melbourne).
8. *Report and Recommendations of the Land Administration Board on the Dawson Valley Irrigation Settlement, 1933* (Govt. Printer, Brisbane).

In land settlement schemes certain elementary economics should be observed. All new settlement involves the expenditure of public funds, whether in the construction of railways or roads, or in the making of advances to settlers to help them in developing their holdings. . . .

Before expenditure is incurred it should first be established beyond reasonable doubt that, directly or indirectly, whether by increased production or by the taxable capacity of the new community, the scheme will, within a reasonable time, pay its own working costs, interest on the loan capital invested, and a sinking fund sufficient to provide for the repayment of the loan when it falls due.

In formulating the Dawson Valley Irrigation Scheme, these preliminary requirements were not observed.

With sublime optimism and confidence, the then Commissioner of Irrigation made estimates of settlement which had no possibility of being realized. Nor was any effort made to check such estimates from other sources.

Perhaps the accumulated knowledge of all Government Departments, and particularly the Lands and Agricultural Departments, would not have been an adequate safeguard in launching such an ambitious project. But the fact is, that all such knowledge remained neglected and unused, and the Commissioner proceeded, unaided, to formulate his plans. . . .

The truth of the matter is that the whole Dawson Valley Irrigation Project, as an economic proposition to the State, was about fifty years ahead of its time. Intense cultivation, with the aid of irrigation, along the banks of our inland river systems, will doubtless come in time, but before even modified schemes in this direction can be economically sound the population and the markets will need to be such as to absorb, at prices profitable to the producers, the products already grown on our fertile coastal belt, with its assured rainfall. Some hundreds of thousands of acres of good cultivable land, much of it alienated from the Crown, is lying unused throughout the rainfall belt, and future schemes for increasing production should aim at the use of this land, instead of more romantic projects for irrigating and cultivating the semi-arid lands of the interior.

In South Australia, salt troubles were widespread in some of the irrigation areas, and considerable sums have had to be written off the cost of establishment and transferred to the general debt of the state. Even in Western Australia irrigation troubles occurred, and many of the early settlers on the Harvey Settlement were unable to carry on their operations successfully.

Regarded solely from the point of view of economic returns, it is clear that large-scale irrigation projects in Australia conducted by governments have been financially burdensome. In part, this result was accentuated by the impact of the low prices received for many farm and orchard products during the economic depression period of 1930-35. But the chief troubles were probably due to technical failures, and to the length of the period which must inevitably elapse before high efficiency can be attained in irrigation techniques. Such efficiency is the resultant of research and extension work acting through the minds of the farmers. This should stimulate them to adapt their farming systems so as to raise the fertility of their soils to the level necessary to support the new types of plants which they introduce

into their pastures, cropping paddocks, or orchards. Taking this view, it is optimistic to expect any irrigation district to pay its way during the early years of its establishment.

More recently, as a result of the dissemination of knowledge gained from research work at various centres such as Griffith and Werribee, the situation has improved greatly. During the war period these districts proved to be the main areas in which the great increase of vegetables required for the forces could be obtained. Apart from this, the districts are by far the most economical regions from which certain types of fruit can be obtained for the local population during peacetime, and, as already stated, the results obtained in recent years from pasture have been very satisfactory, both for dairying and fat lamb production.

When considering whether it is reasonable to expect irrigators to be able to pay both running expenses and maintenance charges on the capital cost of irrigation works, it is necessary to remember that certain subsidiary results have a definite economic significance. In the first place, irrigation leads to a considerable increase in the population of the areas concerned. This, in turn, leads to the establishment of trading centres with attendant secondary industries, and also to a good deal of tertiary employment. All this means higher rateable and taxable value. Railway traffic increases, and the larger volume of freight enables the overhead costs of railway operation to be more effectively borne. In addition, a certain amount of production is available for export, and this increases the national credit overseas. This may be of special significance in that it widens the range of products which can be put on overseas markets, and thus diminishes somewhat the tendency of Australia to rely on a small number of staples such as wool, wheat and dairy products. In all these ways the national economy is strengthened in ways which do not necessarily appear in the return which the state Treasury receives on public capital invested in irrigation works.[9]

Accurate evaluation of these developments is impracticable, but the changes which have taken place in the general appearance of farm houses and farms in these districts during the period when irrigation techniques have come to be better understood leave little doubt as to the improvement in the general status, both of land use and of the community concerned. It is unfortunate that changes in the boundaries of statistical regions and the formation of new groupings during the last two decades have defeated attempts to demonstrate the comparative progress of adjacent irrigated and non-irrigated districts. Some evidence of the progress can be gleaned from the steady rise in the local government status of irrigation centres. Thus Mildura became a city in 1921, Shepparton a borough in 1927, Swan Hill a borough in 1939, Cohuna a separate shire in 1922.

9. East, L. R., *The Financing of Developmental Works* (M.U.P.).

The sociological aspects of the problem also need emphasis. One great factor which has led to the slow growth of most towns in rural Australia has been the lack of amenities available for residents. The ultimate cause in most cases has been the meagreness of the rainfall and the consequent low productive capacity of surrounding districts, which has made it difficult to support a large enough population. Wherever irrigation has been established on the intensive scale the resultant effects of bringing a large centre of settlement into being have been most marked. The civic progress of such centres as Renmark, Mildura, Griffith, and Shepparton during the last twenty years is impressive. The better roads, the improved water supplies, the greater educational facilities, and other public amenities have undoubtedly added a stability to these centres which would not have been possible if the surrounding land had remained as dry-farming country. The importance of this kind of development in national progress should not be under-estimated.

If it may be assumed that the cost of the head works of an irrigation scheme should be regarded as a national liability, the proportion of the cost of maintaining the supply channels and the irrigation services to be borne by the farmers remains to be decided. Naturally, as far as practicable, expenditure of this kind should be balanced by the payments made for the water; but, if the nature of the district and its soils is such that some years must elapse before full productivity is reached, the necessary charges may be beyond the capacity of the farmers. On the other hand, if the water rates are made too low there is a danger that water will be wasted and that all the consequences of over-watering may develop. Further, if the settlement should become particularly profitable, the value of irrigated farms will rise to high levels, and individuals may profit unduly at the expense of the general taxpayer. A policy of restricting such profits may, however, prevent the individual initiative upon which successful development depends. The economical management of a new irrigation scheme is one of the thorniest problems which any administration can have to handle.

Chapter XIV

FORESTRY

1. Forestry and Settlement
2. Nature and Extent of Australian Forests
3. Forestry in Relation to Timber Supplies
4. Future Policy

Chapter XIV

FORESTRY

1. FORESTRY AND SETTLEMENT

IN many areas of Australia that are now relatively closely settled splendid forests originally existed. The normal processes of forest destruction consequent upon agricultural development occurred in Australia. Trees were regarded as an encumbrance, and the efforts of the pioneers and, later, of the saw-millers resulted in a vast amount of uneconomic destruction. The land settlement schemes sponsored by state governments made further inroads into the forests, and, by the end of the nineteenth century, the last waves of settlement began to reach the margins of what could obviously never become agricultural country. Many controversies occurred between the Lands Departments of the states, anxious to provide more land for settlement, and the Forestry Departments wishing to preserve forests.

The attitudes of departments connected with settlement towards the destruction of forests is understandable; but in the main they have been opportunist rather than developmentally sound. For the Lands Departments, the forest areas represent revenue-earning activities like saw-milling and grazing, which they are reluctant to relinquish. The need for a national forestry policy has, however, forced itself upon legislatures; but lack of co-operation and uneconomic destruction still persist at times. The urgent necessity for co-ordinating forest control was emphasized by disastrous forest fires in Victoria in January 1939, which were responsible for the loss of seventy-one lives, much stock and property, and the destruction or severe damage over an area of more than 3,500,000 acres of forest (Plate 73).

The difficulties of the existing situation are well illustrated by the dispersion of control among several authorities of a vital area such as the catchment of the Murray and its tributaries. Investigation has shown that deforestation around the headwaters of the streams in this system is tending to disturb the balance between winter and summer flow, and to render more difficult the whole problem of water conservation for the large productive areas upon which the prosperity of considerable parts of three states is based. Forestry control was not one of the functions transferred by the states to the Commonwealth; and any co-ordination of control depends, therefore, upon the degree of co-operation which it is possible to obtain among state authorities. In recent years when the control of new capital expenditure has passed to the Commonwealth it has become possible to promote a greater degree of co-operation in such matters.

Another aspect of deforestation which is already of urgent importance in all states is the acceleration of soil erosion following the removal of trees and other cover in much of the hill country. The accelerated run-off is causing water erosion and thus impairing the efficiency of the stream beds, and causing havoc in some of the agricultural and pastoral lands on the more level country.

As a result of these developments, forestry policy in Australia, as elsewhere, is devoted to the consideration of two problems:

(a) The reservation of sufficient purely timber country to provide an adequate supply of forest products for future needs.

(b) The protection of the forested catchment areas which function as regulators of stream flow in a continent where droughty periods are the normal seasonal condition.

It is becoming generally accepted that a country should reserve for the future needs of its people sufficient forest to cover the needs which can be foreseen for the probable population. Estimates have been made for the area necessary under modern conditions, and there is agreement that this should be placed at somewhere about one acre per head, although this must vary with the capacity of the country to produce trees. Under prevailing conditions of demand for timber, twenty million acres might be regarded as something of the order of the future need in Australia. At the interstate Conference on Forestry in 1920 it was resolved that a forest area of 24,500,000 acres was necessary to provide for the future requirements of Australia; and this estimate was subsequently adopted at a Premiers' Conference of the same year. It is now nationally urgent that the forest resources of the Commonwealth in relation to future needs should be again reviewed by a competent and courageous authority.

Except where desert conditions prevail, there is comparatively little land in Australia which is absolutely treeless; but, as shown in earlier chapters, a large proportion of the woody vegetation is mere scrub, and has little value except as soil cover and, in certain cases, as reserve grazing material. Even in the areas of dedicated forest, a proportion is of little use for timber, and a great deal of investigation is necessary before the details of the forest position in Australia are adequately known. For instance, the specific conditions under which many of the natural forests regenerate are either unknown or, in many cases, uncertain. The state Forestry Departments are working on such problems.

2. NATURE AND EXTENT OF AUSTRALIAN FORESTS

While it may be said that trees are widespread, dense forests are confined to a comparatively narrow coastal belt. The sclerophyll forests of this belt merge in places into true rain forests, mainly in the highlands. As distance

from the coast increases and rainfall diminishes, the forest growth thins out in all states into a vegetation of the savannah type, which produces little commercial timber.

The main stands of forest useful for timber purposes are found in the coastal areas, receiving thirty inches of rainfall and over in the temperate regions, and seventy inches and more in the sub-tropical north. The total area of commercial timber country is relatively small, and it occurs mainly in the following districts:

(i) A triangular belt in the extreme south-west of Western Australia. The southern portion of this belt contains magnificent stands of Karri (*E. diversicolor*), and to the north of this lies the Jarrah (*E. marginata*) belt (Plate 74). In this region a forest policy designed to give a sustained yield[1] has been established.

(ii) The peninsula areas of southern Victoria, i.e., the Otway (Fig. 30) and Strzelecki Ranges (Fig. 7). These have been reduced to small proportions by settlement, much of which was unwise and has been abandoned. A policy of reafforestation is being adopted.

(iii) The mountain region which is relatively continuous from central Victoria into New South Wales, and extends intermittently throughout the Divide country into Queensland. In this area annual rainfall varies from 30 inches in the south to 160 inches in the north, and dense forests exist in parts. The mountain country of Tasmania is, in effect, an outlier of this region, and forests of much the same type occur as those in the mountain sections of the mainland.

3. FORESTRY IN RELATION TO TIMBER SUPPLIES

The area of dedicated forests, i.e., reserved in perpetuity, is now 18,571,000 acres for the whole of Australia, or seventy-six per cent of the area which forestry experts consider should be permanently reserved. The situation is, however, worse than these figures suggest. A considerable proportion of the area now dedicated contains much mountain bush country or cut-over lands for the rehabilitation of which a long-term policy of afforestation would be necessary. On the other hand, there are still some areas of relatively good forest land in the control of the Lands Departments of some states and these could be devoted to forestry purposes. The estimate of 24,500,000 acres which would be required to supply the timber needs of the future envisages that area of timber-producing forest, but such an area would now be difficult to reserve without special legislation.

1. 'Sustained yield' means that the rate at which a forest is cut is adjusted to its rate of replacement by natural growth, thus providing a steady output of timber and the preservation of the 'forest capital'.

Area of Forest Reservations[2]

(Thousands of acres)

Type of Area	N.S.W.	Victoria	Queensland	S.A.	W.A.	Tasmania	Total
Indigenous Forest							
Dedicated	5,316	4,904	3,281	269[a]	3,367	1,432	18,571
Timber and Fuel Reserves	1,336	(c)	3,097		2,160	314	6,907
	6,652	4,904	6,378	269	5,527	1,746	25,478
Area indigenous forests improved or regenerated	1,418	1,047	429	10	526	2,600	3,432
Area of Effective Plantations							
Hardwood	0·4	2·5	2·7	4·0	15·8[b]	0·4	25·7
Softwood	40·1	46·4	29·8	99·3	13·5	1·6	230·6

(a) Includes timber and fuel reserves.

(b) Mallet (*E. occidentalis*, var. *astringens*) bark for tanning.

(c) Not available.

2. These figures are taken from the *Commonwealth Year Book*, 1942-43. According to some authorities the areas of natural regenerated forests are understated.

Fig. 72 shows the origin of Australian timber supplies for each year since 1910. Its chief features are, first, the high proportion of imports in the period between World War I and the economic depression of 1930-35; secondly the low consumption between 1930-34 which was largely a result of the reduction in house building; thirdly the recovery of local production from 1935-39 owing, partly, to increased tariffs which forced the use of more home-grown timber, and partly to the better technical methods adopted by the saw-milling industry; and finally the great increase in local supplies during World War II when various expedients had to be adopted to meet the requirements of the armed forces. During this last period forest reserves had to be cut ruthlessly in order to attain the needed timber and paper supplies; great use was also made in Victoria of the dead timber left standing after the fires of 1939.

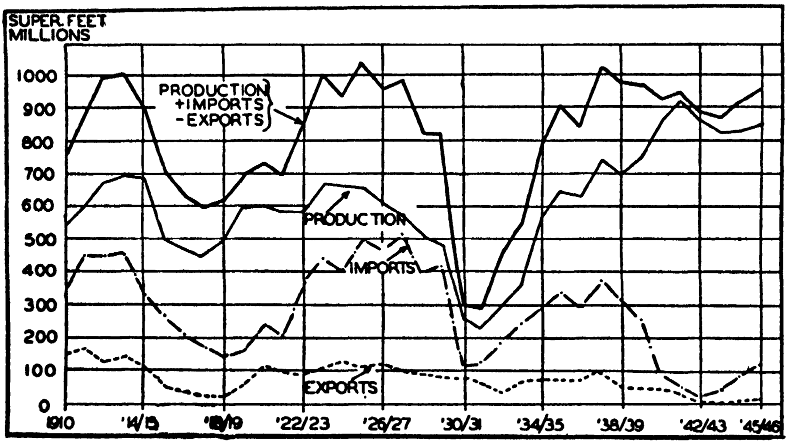


Fig. 72. Timber Supply for the Commonwealth

(Based on information kindly supplied by the Commonwealth Forestry and Timber Bureau)

In general, it is not easy to see how the demands of the next decade will be met without a return to importations of the 1936-38 level. A few forests which have been too remote in the past are now being used; it may prove practicable to use certain species previously considered unsatisfactory for timber purposes. Certain plantations of softwoods, the felling of which was expanded during World War II, are reaching maturity but these are relatively small in area. It seems certain that the timber industry will not be able to provide the full needs of the housing programme, and that alternative materials will have to be used to some extent.

In addition to timber, Australia has been dependent on other countries for many other products of the forest. The local paper industry imported nearly all its pulp until 1938. Since that time several large mills have been

opened for the production of newsprint, kraft paper and some types of 'fine printings'. These are making further inroads into the timber reserves, although some of the trees used can be those which are unsatisfactory for timber (Plate 76). Up to 1947 all rayon used in Australia has been imported.

The problem of providing timber for local requirements is complicated by the tough nature of much of the wood and the need for careful seasoning. The C.S.I.R. Division of Forest Products which started in 1927 has given excellent service in many directions. It has worked out systems of kiln drying and given advice to millers on the subject; it has investigated each timber microscopically and thus has been able to suggest the use of appropriate types for special purposes; it has drawn up standard specifications and made innumerable physical tests. All these enquiries have played an important part in encouraging the use of local timbers. Despite all these improvements the great majority of local timbers are heavier and harder to work than imported varieties and the tendency in the trade is to prefer the softwoods for many purposes. Economic conditions also often favour the latter as costs of producing the timber are often high. Many of the forests are at long distances from the chief centres of use, and they are not located near waterways, so that more expensive rail or road haulage is required. Capital is needed for the development of roads to these areas and in the past it has not always been available. The fire risk is very high at certain seasons, and when once a 'crown' fire starts in a high forest and conditions favour it, nothing but a change of wind can possibly stop it. Apart from these natural disadvantages it must also be recognized that a considerable section of the timber trade is located at the ports, and finds it much easier to handle logs from the ship than from the inland.

The following table shows the quantities of imported undressed timber, including logs (exclusive of timber not measured in super feet), and the countries of origin for 1938-39.

Country	Millions of Super Feet
Canada	297
U.S.A.	12
New Zealand	11
Other British countries	11
Sweden	5
Philippine Islands	7
New Caledonia	2
Other foreign countries	3
Total	348

Source: *Commonwealth Year Book*, No. 33.

By far the larger proportion of the undressed timber imports consists of softwoods such as oregon, redwood, hemlock, western red cedar and yellow pine from North America; and kauri, rimu and white pine from New Zealand.

Local indigenous softwoods are rare, except in Queensland and northern New South Wales, where Hoop Pine (*Araucaria Cunninghamii*) and Bunya (*Araucaria Bidwilli*) grow well in some localities. Most of the original forests have now been cut out, but regeneration and plantation are proceeding. Small natural forests of Cypress Pine (mainly *Callitris glauca*) are cut at a few places in New South Wales and Queensland, but the trees do not grow to large size and consequently the uses to which the timber can be put are limited (Plate 75).

The Forestry Departments in the different states are taking steps to remedy the deficiency in the production of softwoods in Australia; but both areas with suitable conditions for the production of conifers, and resources available for extensive planting, are limited. The acreage of effective conifer plantations is less than 240,000, and the total production from this area, even when in full bearing, will do little to meet Australia's need for softwoods.

Plantations have been made at numerous places, many of which have proved unsuitable as regards soil or climate, or both. In early years this lack of success was partly due to the incorrect assumption that pine forests would grow well on poor soils; starting from this, forestry departments naturally acquired poor areas which were not required for agricultural or pastoral settlement. In recent years much more attention has been given to the ecological requirements of the trees, and more success has been achieved. The most notable achievement has been the large-scale development of state and, to a lesser extent, private forests in the south-eastern section of South Australia, where *Pinus insignis* forestry is now well established. Experience in other states has been similar and in south-eastern Queensland some success has attended the plantation of species suitable for the production of turpentine and other by-products. Programmes of development require the investment of large amounts of capital; and, in the past, harassed state Treasurers have regarded forestry as a source of revenue rather than a legitimate reason for expenditure.

4. FUTURE POLICY

Mr. S. L. Kessell, ex-Conservator of Forests in Western Australia, who was timber controller during the recent war, has summed up the position as follows:

> The practice of forestry requires long vision and patient and intelligent planning for the future. Under Australian conditions it is essentially a function of governments, who must be prepared to make special financial and administrative provisions for necessary continuity of policy and management. A stage has been

reached in our national development when we should emerge finally from the chaos of pioneering settlement. . . . Many millions of acres of useful forest have been slaughtered and burnt. Much of this was inevitable in the establishment of essential pasture and farm land, but ill-considered clearing and grazing projects on land more suited for forests than farms have rendered many tens of thousands of acres unproductive.

The application of the principles of sound forest management to the forests of Australia bristles with difficulties. Sawmills have been established and trade practices have grown up over a long period of years, during which the forests have been treated as timber mines to be worked out and left. Land has been alienated in and around the forests without regard to routes of access or the value of natural boundaries in connection with fire control and logging operations. At a late stage in the exploitation of the forests, when they have been cut over and ravaged by fires for many decades, foresters are being called upon to make good the results of past neglect, and, at the same time, maintain production without undue interference with the established timber industry.

There is reason to believe that the wartime experience may have taught the lesson of the need for an adequate developmental policy in relation to the problems of forests and timber supplies. The danger is that as supplies from overseas become available, the easier way of relying mainly on importations for which the consumer can pay will be adopted, as opposed to the more difficult course of building up efficient forestry services, adopting effective fire control measures, reafforesting despoiled cut-over regions and planting large new areas—procedures which will require large disbursements from consolidated revenue or the allocation of considerable capital sums.

Much more might be said upon the preservation of native forests and the need for a large-scale national plan of afforestation. There are few aspects of land utilization that present problems of such urgency. Whereas most other production in Australia can easily tend towards over-production in relation to markets, the timber crop is deficient, and, in relation to even the existing demand, is declining. When the forest needs of the future are considered, the deficiencies may become little less than tragic.

Chapter XV

THE EFFECTS OF WORLD WAR II ON AUSTRALIAN FARMING INDUSTRIES

1. Developments During the 'Phoney' Stage of the War
2. The Phase Between Dunkirk and Pearl Harbour
3. The Period of Conflict in the Pacific
4. Preparations for the Future
5. The Post-war Position

CHAPTER XV

THE EFFECTS OF WORLD WAR II ON AUSTRALIAN FARMING INDUSTRIES

SPECIAL consequences of the conflict of 1939/45 upon Australian farming have been referred to many times in the preceding chapters, but the far-reaching effects of the war upon land use and the rural community in general have not been discussed. It now seems desirable to bring the whole story into historical perspective, and to relate continuous adjustments during and after the war to both internal and external causes.

1. DEVELOPMENTS DURING THE 'PHONEY' STAGE OF THE WAR

Even before the outbreak, successive Australian governments had recognized that world war would again raise serious problems for all those industries which relied upon selling their surplus production overseas. Plans for such an emergency had therefore been laid; and, within the first few weeks, arrangements were announced under which the British government agreed to purchase the entire wool-clip and the exportable surpluses of dairy products and meat at prices which were temporarily fixed, but which could be subsequently varied by agreement. These prices were for delivery at the Australian seaboard, so that any increase in the costs of shipping freight would not affect the producers. They were reasonably attractive when compared with those which had ruled during the preceding years.

Other industries found themselves in a more difficult position. The wheat industry, with a large reserve of grain, had a difficult time. The way in which its problems were handled has been described in chapter VII (pp. 149 *et seq.*). Fresh fruit, being bulky, of low nutritional value, and requiring careful transportation, took lowest place on the list of primary products for which refrigerated space would be found. The government scheme has been discussed in chapter XI (pp. 240 *et seq.*). The wine industry feared it would be unable to dispose of its surplus and had no rapid means of expanding its storage capacity. A scheme for its rationalization was therefore investigated.

These various arrangements enabled the farming industries to carry on for the time being in a normal way. As the months passed, farmers in general began to look for some lead from the government indicating the directions in which they could take a more active part in supporting the war effort. Unfortunately such a lead was not available, presumably because the government was not prepared to take the risk of stimulating greater production owing to the shipping position, and also because most of the normal sources of supply were, at that time, still open to Britain. However, a campaign for

increasing the production of flax was launched, and investigations which had previously been made into the possibilities of providing certain drugs of vegetable origin were expedited.

Many of the younger men on the farms, and also others operating farms in the less reliable areas, found this state of affairs unsatisfactory. They began to move into one or other of the Services, or into the expanding munition industries. Higher wages, and the feeling that they were contributing more definitely to the war effort were factors in stimulating this movement of both men and women from the country to the cities.

2. THE PHASE BETWEEN DUNKIRK AND PEARL HARBOUR

The war suddenly became more intense in April 1940, as the Germans successively over-ran one country after another, and, later, when the entry of Italy closed the Mediterranean route for Australian exports to Britain. That country was now forced to try to find substitute imports for the large portion of her foodstuffs which had previously come from Denmark and Western Europe. The Australian government at once took steps to increase dairy production, particularly cheese, and to expand meat-canning operations and the drying of eggs. Dehydration of mutton, in order to reduce the shipping space required for its transport, was also investigated. At this stage the shortage of shipping dominated all export planning, especially in view of the difficulty of transporting food and equipment to Britain or to the Middle East where Australian forces were in the field.

During the early stages of establishing controls over production, a certain amount of bungling was to be expected. For example, the value of bacon as an easily cooked food was recognized, and during 1940 a large increase in pig production was stimulated. In January 1941, export was limited to the heavier baconer types, and producers were advised to carry their animals on to this stage of development. In March 1941, however, it was stated that Britain would in future receive only porkers, and consequently large numbers of producers who had over-sized animals on hand were forced to put these on the market at ruinous prices. Producers met severe losses which the government made no attempt to bear, and rumours that some large firms who had bought over-sized pigs earlier in the year were able to sell them at a handsome profit when the government reversed its policy later, did not help the situation.

During this second phase of the war recruitment went steadily ahead, and Manpower Committees were set up to decide how to direct the most efficient use of labour. In some cases these powers were not exercised with great discretion, and a large number of farmers whose sons, daughters, and hired labour left for the Services or war industry carried on only with the utmost difficulty.

3. THE PERIOD OF CONFLICT IN THE PACIFIC

The third phase of the war opened with the bombing of Pearl Harbour by the Japanese in December 1941, and progressed in intensity as the Allies suffered a series of defeats in the South-West Pacific. Early in 1942 American forces began to arrive in Australia, and they continued to increase in number until over a million U.S.A. personnel of all arms were stationed in Australia. This phase of the war naturally intensified still further the difficulties of shipping, but the demand from such a large number of additional consumers in the Commonweath, who relied on local production for the bulk of their foodstuffs and much equipment, greatly reduced the surpluses available for export. Food rationing was introduced in order that the maximum amount could be made available for national purposes or export.

The United States forces set Australian agriculture many urgent special problems. They were totally unused to eating mutton, of which there was a surplus, and insistent in their demand for pig products, of which the country had no great surplus. They required urgently many specialized foods which had previously only been produced in moderate quantities (e.g., oranges) or were in short supply (e.g., special kinds of vegetables). Demand for whole milk was especially heavy, and came at a time when the dairy industry was feeling its labour shortage severely. Australia did its best to supply these varied requirements, but the limitations of area suitable for some of these forms of production, and of cultivators who had any experience in the vegetable crops, meant considerable difficulty and quite an amount of wasted effort. The American government sent experts to Australia to advise upon production and arrange for importation of machinery, but there was inevitably a time lag between planning and actual production. Oranges and bacon virtually disappeared from the civilian market, and the strain on supplies of dairy products in some localities was particularly severe. Potatoes and vegetables were at times very scarce, whilst even apples were not available in some states because of transport difficulties. As the American concentration of troops moved northwards up the Queensland coast, difficulties became greater. The problem was increased by the government requisitioning many ships previously engaged in the interstate trade. This meant that the railways had to carry a treble burden—usual state loadings, special military traffic, and tonnage which would normally have gone by sea. In Queensland and Western Australia, where the railways are narrow-gauged and usually have only a single track, the effects of overloading, congestion, and urgency of supplies were exasperating and at times disastrous.

This complex of both production and distribution problems was met, on the one hand, by a rigid system of price control, which worked effectively and prevented producers and distributors from taking undue advantage of the shortages, and, on the other, by attempts to stimulate the production of such crops as vegetables and potatoes through a system of guaranteed prices offered

to growers on a contract basis. As time went on these devices were generally effective in securing increased production, but since the terms of the contracts had to be generous in order to attract the interest of producers and stimulate them to make the very considerable extra effort which was necessary, they forced a general rise in the price limits fixed by the Prices Commissioner. In so far as the contract system succeeded in attracting farmers, it also led to a considerable diversion of effort from production of the more standard types of commodity. Manpower to develop new lines of production was not available, and the labour for the new enterprises had therefore to be diverted from other farming industries. This was particularly difficult in the dairying industry, which had a bad name for offering low wages to its employees; some dairy farmers considered it more profitable to plough up good dairy pastures in order to grow potatoes, to the detriment of milk production. Unfortunately, the wheat districts—in which there was a surplus of production—are climatically unsuitable for the production of most other crops, or even for dairying. The way in which this situation was met has been described in chapter VIII (p. 200).

Another vital difficulty concerned the lack of superphosphate. Australian supplies of phosphate rock had previously been obtained almost entirely from Nauru and Ocean Island in the Pacific, which were now in Japanese hands. Other sources of supply were much further afield, and had to be drawn from the Middle East, which meant that only limited amounts could be made available. These were of lower quality than the normal Pacific supplies and were only obtained at much greater cost. The Commonwealth therefore subsidized the importation of phosphate rock, and introduced a rigid scheme of rationing to producers. The cost of the subsidy to the superphosphate industry in the four years ending 1945-46 was about £7,500,000. It seemed to the government to be better policy to meet the emergency through subsidies rather than through a large increase in price. A similar policy was adopted with regard to the importation of wool packs, bags, and sacks, supplies of which were also rationed, and £2,000,000 was spent in subsidizing these prices.

The general organization and control of agriculture was put on a new basis. In the past, co-ordination between the activities of the various state Departments of Agriculture had been arranged under an Australian Agricultural Council[1] which was organized by the Commonwealth Department

1. Co-ordination between the Federal authorities and the state authorities, and between each of the state authorities, is through the Standing Committee on Agriculture, a technical body, and the Australian Agricultural Council, which is political in character. On the Standing Committee the Commerce Department and each of the state departments are represented by their respective permanent heads. The C.S.I.R. is represented by one or more of its members. The Standing Committee deliberates upon agricultural problems, both administrative and technical, and prepares and recommends proposals and plans for the guidance of the Australian Agricultural Council, which consists of the Minister for Commerce and the Ministers of Agriculture of the six states.

of Commerce. Under wartime regulations the Federal government increased the scope of that department, and altered its title to 'Department of Commerce and Agriculture.' Presumably the intention was to set up a central authority to regulate agricultural activities in general. It soon appeared that the personnel for such a department could only be recruited by taking men away from state departments which were already under-staffed. As a Commonwealth department could only operate through or with the extensive assistance of state departments, the process could only be one of robbing Peter to pay Paul when both were in the same organization. In addition to this change, the Australian Food Council was set up in the middle of 1943 with special powers to arrange supplies.

A scheme of District War Agricultural Committees was set up throughout the closer settled regions of the continent; in these prominent farmers and state officials were able to carry out very useful work. These committees became the bodies which had the task of deciding the allocation of the very limited amounts of machinery, fencing material, and other supplies which were available. Their success varied from district to district, but in general they served to provide a means of assuring farmers that an attempt was being made to bring them more closely into the war effort and to meet their legitimate demands as far as practicable.

The position of the sheep and wheat industries, which were producing in excess of the market demands for the time being, was different from that of most other industries. The wheat industry received a somewhat higher price than in the years preceding the war, but payments from the Pools were slow. Further, in order to attract extra labour at harvest time, the principle of fixing wages for such labour was adopted, and this in itself involved higher costs for most of the farmers. The wool industry was in a particularly difficult position because the contract price for wool, although not excessive, was reasonably attractive and sheep numbers increased considerably, while at the same time there was a demand for meat. An investigation was carried out with the idea of setting up a scheme to reduce the size of the flocks, but this was violently opposed. As a result, the sheep population remained at a record figure until 1944/45 when a general drought swept the country, which was by that time short of animal or any other foodstuffs for stock feeding. Stock losses were of the order of 20,000,000.

This drought period was also disastrous to the wheat harvest in most states except Western Australia. In Victoria, the position became serious, for the 1943/44 season had produced an unusually low crop of 19·7 million bushels and this was followed by 3 5 millions in 1944/45. Reserve stocks had been used up for livestock feeding, and wheat and other grain had to be brought from Western Australia by sea. The dairy industry suffered some loss of production and was partly assisted by the importation of hay from Tasmania.

4. PREPARATIONS FOR THE FUTURE

When the immediate danger of invasion had disappeared and it seemed only a matter of time before the Japanese army would be overcome in the Pacific, the government realized that there was a need for a general survey of the agricultural position. The depression of the 'thirties had reduced the initiative and morale of the countryside, while subsidies and grants had become so frequent that they were a burden on the Commonwealth Treasury. Accordingly, early in 1943, a Rural Reconstruction Commission of four persons was appointed to investigate the whole position of the agricultural industries in the Commonwealth. This body set to work to make the survey required of it and produced ten reports.[2] The first of these was a broad general survey of the position in the farming industries and of affairs in the countryside in general. The second reviewed the possibilities of developing schemes for settlement on the land of men returning from the Forces. The third report surveyed the problems of land utilization and of farm settlement as they occur in Australia, while the fourth dealt with ways by which unsatisfactory farm ventures might be economically reconstructed. The fifth was concerned with rural credit, and the sixth gave a broad survey of the efficiency of Australian farming in relation to costs, and of the various factors which determine it. The seventh report dealt with the general problems of the countryside in relation to the amenities which the farmer and those who live in country districts could enjoy. The eighth report was concerned with irrigation, water conservation, and land drainage; it reviewed the difficulties of establishing irrigation settlements, and also surveyed the possibilities of extending irrigation in the future. The ninth report dealt with land tenures and valuation, and the tenth with commercial policy in relation to the farming industries.

The general picture revealed by these reports is one of need for greater efficiency in many directions, and in particular for a wider appreciation of the necessity of raising soil fertility by better balanced methods of farming. On the economic side the reports stressed the danger of increasing the production of rural industries to such an extent that the ratio of exports to home consumption may become unduly large—unless there is a real prospect of continued international trade in the commodities concerned. The Commission pointed out the folly of trying to press settlement in areas of low and uncertain rainfall, and recommended that authorities charged with the task of making farms available to settlers should concentrate their efforts either on such tracts in the better rainfall regions as had been inefficiently used, or on irrigation districts. The reports were generally well received by the farming community and by the authorities who would be ultimately responsible if the policies recommended were carried out. How far such authorities will be able

2. Published by the Govt. Printer, Canberra.

to resist undue pressure from local interests or from political groups remains to be seen.

5. THE POST-WAR POSITION

The end of the war found Australian farmers very short of labour and most farms in a somewhat dilapidated condition. Probably the majority of operators were in a better financial position than they had been in 1939. Many had reduced their debts considerably. The higher prices for their products, coupled with the fairly rigid control of the prices of items which they had to buy, and the fact that they had been overworking themselves because they could not find labour, had brought this about. The Commonwealth restrictions on the price at which properties could be bought and sold had prevented any general inflation of land values, and checked any large-scale trafficking in farms.

Most farmers expected that peace would bring a rapid solution to their troubles. They imagined that the men would come back from the Forces and the factories, that the materials for replacement and repair of permanent improvements would be available, and that affairs in general would rapidly return to the circumstances of 1939. Their disillusionment has been bitter. Many of the returned men showed no inclination whatever to go back to an industry which had provided so little in the way of wages or amenities during the 1930's. They preferred to remain in cities where wages were higher and the abundant employment available gave them better opportunities of leading a fuller life. Further, the price of rabbit skins was so attractive that many casual workers in the country towns found it more profitable and congenial to spend their time trapping. The lack of materials for renovating fences, gates, buildings, and other improvements continued. Machinery, including tractors, was difficult to obtain, while the high level of taxation pressed heavily on those who had been financially successful. Many of the older men had reached ages at which work itself was becoming unbearably arduous. There was, therefore, little incentive to increase production. This was particularly the case in the livestock industries. Some of the larger dairy farmers turned to cattle-raising, which required less labour. The sheep industry began to build up flocks which had been depleted by the drought, and, being less concerned with making immediate profits which would have gone into taxation, they were prepared to hold their stock or even to buy more at high prices because such a course meant a lower taxable income.

Whether the labour shortage can be overcome in a few years by the return of men from the cities to the land is doubtful in view of the adopted national policy of meeting any serious threat of unemployment by the construction of works of national significance, of which there is a long list awaiting attention. The possibility of obtaining recruits for the agricultural industries by immigration may be the solution, but immigration across the North Atlantic, which takes at most a fortnight, is much easier than

immigration from Western Europe to Australia, which may occupy six weeks and is far more costly.

Plans for the settlement of returned men have developed gradually (Plate 77). In general, the governments have avoided the regions of low and uncertain rainfall. Most of the states have little Crown land of attractive quality left, and that mainly in remote areas. The acquisition and subdivision of large estates has therefore been relied upon mainly for providing new farms, and much more care has been taken in assessing such properties than was the case after the first world war. The Commonwealth government endeavoured to restrict expansion in some industries in which the ratio of exportable surplus to home consumption is large, e.g., the dried fruit industries. The state governments, however, took rather a different view, and some expansion has been planned. In Queensland it was agreed to increase the sugar licences by three per cent in order to provide opportunities for returned men.

The disrupted state of international trade made it necessary for the Commonwealth to continue its control of the marketing of exports in many primary industries. In general, it endeavoured to make long-term agreements with Britain and other countries in this regard. Long wrangles occurred between Commonwealth and states over the price to be guaranteed to the wheat industry. The price of grain used for feeding pigs and poultry has been kept reasonably low. This has made the industries concerned particularly profitable in so far as they have been able to export their products. It also has the effect of keeping the local prices at a reasonable level, but may ultimately result in giving producers a false idea of the stability of their industries over the long term.

A comprehensive survey of the costs of dairying was completed towards the end of 1947 and revealed the need for an increase in the price of the product if labour incomes and the standard of living on dairy farms were to be ensured. The Commonwealth government therefore guaranteed a price equivalent to about 2s. 5½d. per lb. for butter-fat for the ensuing five years, which required a considerable increase in the price of dairy products on the local market and, in addition, a subsidy from the Commonwealth Treasury.

The initial stages of the Joint Disposals Organization's plan for selling the surplus stocks of wool which had accumulated during the war met with rather unexpected success. On the resumption of the auction system for selling wool in 1946, the prices for high-grade fine wools reached very high levels. However, the less desirable and burry types only showed very moderate increases in price, and the rate at which the accumulated stocks of these could be disposed of was not wholly satisfactory. The wool industry was sufficiently realistic to regard the increase in the price of its products with some apprehension since it was realized that, for many purposes, the use of substitute fibres would be thereby encouraged. On the other hand, the

profitable returns from high prices at the sheep sales were a large source of income to those who sold. Most wool-growers, however, were inclined to hold their stock wherever possible because the loss of possible profit only meant a smaller amount of taxation. Such high prices for sheep are, however, unlikely to be a permanent feature of the wool industry.

At the end of 1947 most farmers probably recognized that their time of economic difficulty had not yet arrived. The majority were facing the future with some misgiving as to how far they would be able to maintain a satisfactory economic balance when the prices of their products began to recede and the costs of the commodities they buy show no such recession or may even continue to rise.

CHAPTER XVI

EFFECTS OF WORLD ECONOMIC TRENDS UPON LAND USE IN AUSTRALIA: 1920 TO 1947

1. Land Use and World Markets
2. Improvements in Productive Efficiency
3. The Effects of Economic Policies upon Land Use

Chapter XVI

EFFECTS OF WORLD ECONOMIC TRENDS UPON LAND USE IN AUSTRALIA: 1920 TO 1947

DURING the decade following World War I, and in the years following the economic depression of 1930, changes in the world economic structure greatly affected primary production in all countries. A world-wide monetary inflation collapsed in 1929, and a catastrophic fall in prices for all products of the land followed. The net effect of this fall in prices was to plunge every agricultural and pastoral occupation into difficulty and disorder. Each of the countries exporting primary products tried to offset the fall in export income by increasing its volume of production and exports. This change in the economic position of primary production was accentuated by policies of self-sufficiency expressed in higher tariffs and in actual restriction of international trade through control of monetary exchange. The effects of these movements continued until 1939 with some modification from 1937 onwards as international trade improved somewhat, owing to the attempts of nations to build up reserves for use in the event of war.

The outbreak of World War II set in motion the most far-reaching economic changes, from the concentration of national resources upon winning the war to economic controls of every kind. It is now necessary to gather up these economic influences, and to consider their effects upon land use in Australia. Wartime changes of land use and post-war developments connected with land settlement, along with changes due to shifts in labour and capital resources, were discussed in the preceding chapter.

The broad influences affecting primary production considered in this chapter fall mainly into those affecting demand and those affecting supply. Concerning demand, we have to consider (i) those influences related to the growth or decline of populations, and (ii) those arising from monetary or trading agreements, or from changes in distribution of international purchasing power. Concerning supply, we must examine the long-term influences operating to change either the quality or the quantity of output through expansion of area used or technical improvements in production.

The reactions upon land use, set up by changes in population, in policy, or in the technique of production, are difficult to state in precise terms. The causes are definite, but the effects are spread widely throughout the national economy. The endurance of a rural economy under repeated financial shocks and the persistence of methods of land use are, moreover, beyond explanation in terms which are wholly economic. Whether Australian responses to far-reaching changes in the world economy after 1939 will result in fundamental alterations in land utilization cannot be foretold. Too

many possibilities enter into such a long-range calculation, although some adaptations and tendencies are already perceptible.

1. LAND USE AND WORLD MARKETS

Population Trends

The first of the changes in world markets between 1920 and 1947 was the result of a slackening in the growth of the population of certain countries. In the chief importing countries there can be no expansion in demand unless either the numbers of their people increase or the level of consumption per head rises. In the light of post-war uncertainty throughout the world, it is not possible to predict future changes in standards of living. It is, however, possible to indicate with fair precision the probable changes in the growth of population for various countries. Since this trend is calculable, despite the toll of war, the ascertainable facts of the world population situation have been, as far as possible, brought up to the time of writing. Some indication of probabilities, also, has been attempted.

Thanks to the work of Kuczynski and others we now have reliable indices of the growth capacity of different populations. For our purpose, the important question is whether there will be more or fewer women of the reproductive ages (15-50 years) in the next generation, as compared with the present one, since it is upon the number of potential mothers that the capacity of a population to reproduce itself depends. It is possible to calculate the number of females—the future mothers—likely to be born to 1,000 women passing through child-bearing age. The calculation gives us the maximum possible number of future mothers per 1,000 present mothers on the assumption that birth and death rates do not alter, and that all the female babies themselves live through the age of reproduction. This is the *gross reproduction rate*. When allowance is made for mortality among women of child-bearing age, we obtain a *net reproduction rate*. The net rate is, therefore, definable as follows: the number of females likely to be born to 1,000 women passing through the child-bearing age, and likely themselves to survive through that age; more crudely, as the number of potential mothers in the next generation compared with the number in the present generation. Assuming present birth and death rates, if the net rate is above 1,000 the population is increasing; if below, decreasing; if just 1,000, it has a *replacement rate*. Comparisons of gross and net rates for different countries are given on the following page.

Fertility statistics indicate two facts of considerable importance to this study. In the first place, the fertility rate for the whole of Europe and North America, i.e., for the chief countries to which Australia exports, is probably over the long term still declining. The fall in the replacement rate for Australia's chief market is, from this point of view, disquieting. The population of the United Kingdom is no longer growing by natural increase. In

Reproduction Rates, Selected Countries[1]

(Annual average per 1,000 of population)

Region and Country	Reproduction Rates		
	Gross	Net	Year
N.W. and Central Europe			
England and Wales	0·90	0·81	1938
France	1·00	0·88	1936
Germany	1·06	0·93	1940
Hungary	1·21	1·00	1938
Netherlands	1·26	1·16	1941
Sweden	0 89	0·79	1936
Denmark	1·09	0·96	1941
Belgium	0·80	0·67	1941
S. and E. Europe			
Italy	1·43	1·13	1935-37
Poland	1·50	1·11	1934
Rumania	2·16	1·40	1930-31
U.S.S.R.	2·70	1 70	1926-28
Beyond Europe (white)			
U.S.A.	1·09	1·00	1940
Canada	1·42	1·27	1940-42
Australia	1·16	1·06	1942
New Zealand	1·30	1·21	1942
Chile	2·26	1·30	1930-32
Asiatic			
India	2·96	1·40	1930-31
Japan	2·15	1·44	1937

the second place, while the decline is world-wide, the gross fertility rate of Asiatic peoples is considerably higher than for countries of white population. The implications with regard to the future capacity of European countries to consume primary products, under depressed purchasing power and standards of living, are of great significance for Australia, as also is the increase in the numbers of Asiatic peoples, which is now estimated to be at the rate of about two millions a month. The U.N. Food and Agricultural Organization has consistently warned that the peoples of Asia and Europe are now underfed, on the average; and that greater efficiency in production of foodstuffs and higher economy in their distribution will be required to maintain even the standards prevailing before 1940. If it is possible, in the long run, to lift standards of consumption for an increasing number of Asians, their countries

1. Figures from *A White Australia* (Australasian Publishing Co., Sydney), chap. 1, by W. D. Borrie; *Annals* (Amer. Academy of Pol. and Soc. Sci.), 1945, *World Population in Transition* (McGraw-Hill); and *Population Index*.

alone will require all the increase in output of food which seems possible throughout the world.

The implications of population changes now in progress are far-reaching and of vital importance to countries like Australia in which the economy is still largely dependent upon export production. These consequences have been examined by H. D. Henderson,[2] and should be considered for the main purpose of this study. Henderson holds that the severe world agricultural crisis after 1930, and the vigorous movement towards economic nationalism, are largely the result of the slowing down in the rate of growth of the white peoples. The rapid growth of numbers in countries like Great Britain during the nineteenth century was the main dynamic accounting for the astonishing development of international trade which characterized the period, and for the free trade tradition. As numbers increased, the demand for food grew correspondingly, and this increase in demand was greater than could be met by the ordinary process of technical improvement.

In order to keep up the supplies of food, it was necessary, therefore, to provide for a progressive enlargement of productive capacity, by improving agricultural techniques as well as those of transport, financial and handling services. Enlarged productive capacity was secured, in the first place, by developing the virgin agricultural resources of the 'new' lands; and a large increase in both the quantum and value of world trade followed.

The equilibrium established by this means between the demand of industrialized countries and the supply of primary producing countries prevailed as long as the population growth of Western peoples was maintained. When this growth slowed down, the whole system of world economic relations was transformed. The new disequilibrium was abruptly realized after 1930, and the realization accelerated changes in national economic policies which threw world trade and production into chaos. A position had been reached when the annual increase in the demand for many important agricultural commodities is perhaps less than could be taken care of by the ordinary process of agricultural improvement. Taking into account the economic re-organization of India now being planned by the authorities of that country, the effects of the civil war in China, national movements in the countries of S.E. Asia, and the industrial developments in Japan, it seems certain that the twentieth century phase of world economic adjustment in land use is likely to far transcend that of the nineteenth century. *Laissez-faire* as a theory and a practice was the outcome of expansionist conditions, but, as Henderson shows, when problems of surplus capacity arise frequently, unrestricted competition does not work so well—need is felt for methods of organization which will permit the deliberate adjustment of supply to demand. We need look no further for the impetus towards economic nationalism in our time; and, over the long term, this impetus is still powerful. These

2. See Henderson, H. D., *The Population Problem* (ed. Marshall), esp. chap. 1, 'The Agricultural Problem'.

problems, with particular reference to Australia, have been continuously examined by Colin Clark[3] and, in relation to post-war reconstruction, by the Rural Reconstruction Commission appointed by the Commonwealth government,[4] and in a paper by S. M. Wadham.[5] Pre-war, about half of Australia's agricultural produce was exported, Britain being the only important buyer. If world trade declines, or if prices fall seriously, agricultural reconstruction will have to be on a major scale. It follows that increased farm efficiency will be imperative. So world prices, terms of trade, costs of production, technical efficiency in land use, are all intimately connected. In the background is the declining proportion of the population employed in rural pursuits in primary-producing countries and the associated problem of alternative employment.

Despite post-war conditions of short supply for primary products, the discussions at economic conferences in recent years have revealed persistent fears of a return of world economic depression, of a fall in prices of trade commodities of all kinds, and of the possibility of surplus stocks. These fears explain the policies in Australia and other countries designed to promote industrial self-sufficiency, and the emphasis placed upon full employment in agreements for international collaboration. For the trading world as a whole, and for each country which adheres to the international system, unemployment problems are not likely to be eased by a decline in the rate of population growth. Even a maintenance of existing numbers would involve great difficulties of adjustment, especially in India[6] and China. In the economic conditions of the nineteenth century unemployment was usually adjusted over the long term by transference of labour and capital from old and declining into new and expanding industries. Such transference was easier under conditions of increasing population, representing growing demand for both capital and consumer goods, and when the percentage of employed in the younger age-groups was relatively large. In the twentieth century economic adjustment has tended to press more heavily upon primary-producing countries relying upon external markets. They have had to transfer labour and capital from primary occupations to other forms of employment; and deliberate policy has had to be applied to secure that measure of equilibrium in the balance of industries which was formerly automatic and spontaneous.

The situation in Australia with regard to population increase has scarcely been encouraging since the world economic depression after 1929. The rate of natural increase fell sharply until 1934, though it rose again during the 1940's; and the increase by migration is now rising by intake of displaced persons. Australia, like the United States, benefited by migration when the

3. Clark, Colin, *Conditions of Economic Progress*, (1940) (Macmillan); *Economics of 1960* (1942) (Macmillan).

4. *Reports of the Rural Reconstruction Commission* (Govt. Printer, Canberra).

5. In *Australia's Post-War Economy* (Australasian Publishing Co., Sydney).

6. Downing, R. I., *Economic Background of Social Policy in Asia*. Paper before Section G, A.N.Z.A.A.S., Perth meeting, September 1947.

European net rate of increase was as high as Japan's is today. Migration from Europe to Australia became difficult for some time after war ceased, because of the shortage of ships and because of political barriers in Europe to the movement of people, but mainly because most countries desire to keep their young people. In contrast to this slackening in the Australian rate of population increase is the policy of rural development which will almost certainly lead to expanded production in some commodities. The prevailing (1947) urgent demand and high world prices for primary products are resultants of wartime destruction and post-war inflationary conditions. The long-term probabilities will depend upon the success of plans for international economic collaboration far more than on reproduction rates or on migration movements. The whole problem of more intensive land use in Australia will be increasingly studied in the light of the population trends we have examined, and of particular aspects of international economic agreements which we now discuss.

Policies of Economic Self-Sufficiency

Two forces of another kind may cause a contraction in the markets for primary products. In the nineteenth century, the theory was widely accepted that the countries of recent colonization should specialize in the production and export of primary products in exchange for factory products. In the twentieth century, largely owing to agitation for greater diversity of industry, the trend in these very countries, in response to fundamental pressures which we have already examined, is towards expansion of factory industry. It is now commonly held that stimulation of secondary industry is justified, firstly, because factories represent more numerous and more varied opportunities for employment, and secondly, because they provide the ideal home market for farm products. This demand for expansion of secondary industries has been met in Australia, as elsewhere, by the use of tariffs. The urge, indifferently for profit, self-sufficiency, or larger home markets, has been responsible for a great enlargement of domestic factory industry in countries as different as China and New Zealand, India and Australia, Canada and Japan. This expansion of factory industry is a response to internal economic and political pressures.

Self-sufficiency has, however, taken a second and more powerful form. This finds its justification in the belief that a country should plan its industries so as to be strong in the event of war. As a result most countries, especially in Europe, remodelled their production and trade after 1933 in order to command more adequate resources for war purposes. Every known financial technique and economic device was used to achieve self-sufficiency.

These pressures for greater self-sufficiency, operating concurrently, changed the structure of world trade and of territorial specialization at an amazing speed. Individual nations or groups of nations retired, mollusc-like, within their economic shells, and concentrated their efforts upon such a

development of internal resources as would make them economically independent. This was the climax of protectionism, and it ran the whole gamut from schemes of imperial preferences to trade by licence or export bounties. As the system of exchanging specialized production was undermined by economic nationalism, more particularly after 1930, both the volume and value of world trade rapidy contracted.

A world-wide movement, incited by economic depression after 1930, took the form of governmental control of trade and production in most countries. For Australia, in particular, the system of Imperial preference written into the Ottawa Agreements of 1932, on the one hand, and the restrictions imposed upon imports in former customer countries, on the other, both tended to intensify Australian dependence upon the British market. Moreover, the policies of 'imperialist blocs' had divided the world into more or less exclusive areas of trade, and the export production of the large group of primary-producing countries attached to the sterling system was, naturally, concentrated upon the British market. Sales competition was intensified and prices were correspondingly depressed; but, at whatever prices primary products had to be sold, the consumptive capacity of 45,000,000 people in the United Kingdom was limited. By contrast, for Germany and Japan, access to foodstuffs and raw materials depended on their ability to export manufactures, which was cramped by the tariffs and trade-diversion policies of other countries. Interdependence, which was the natural order of things in a world of specialized production, clashed violently with self-sufficiency policies looking towards strength for war.

Control Schemes in Australia[7]

Before World War II, the influences of trade restriction as far as the Commonwealth was concerned arose from control schemes in Australia, on the one hand, and the system of Imperial preference on the other. Within a framework of normally socialistic government in Australia, a trend towards regulation of trade and industry had long been accepted as the natural regime. When this tendency was strengthened by the exigencies of World War I, government control of marketing became inevitable. During the years from 1914 to 1919, primary producers looked to governments for assistance in marketing their products, and control schemes for wheat, wool, and meat were established. After the war, when governments wished to relinquish schemes that had become politically embarrassing, some groups of primary producers wanted to perpetuate control through voluntary organizations for orderly marketing, price stabilization, and sales propaganda.

Gradually, a method of compensating the producers of certain commodities for having to work under the high costs of a tariff system was evolved by fixing home prices at some level above world parity. Subsidies by

7. See Bailey, K. H., and Giblin, L. F., 'Marketing and the Constitution,' *Economic Record*, Dec. 1936; also Wood, G. L., 'Co-operation in Australia,' in the *Year Book of Agricultural Co-operation*, 1938 (King).

means of tariffs were paralleled by bounties, in some cases direct, in others by fixing home prices. Unfortunately, neat domestic solutions for commodities such as butter, dried fruits, and sugar had to be fitted into a developing imperial marketing system in which wider bounds of regulation and restriction had been set. But it seemed clear that, if the British market had its limited absorptive capacity at world prices, the Australian market was even more definitely limited at prices higher than world parity. A day of precarious balance of conflicting interests, calling for delicate adjustment within and without the Empire, had dawned. Marketing difficulties accumulated. In 1936, the High Court of Australia declared in effect that the interstate marketing schemes for dried fruits and butter were unconstitutional, and forced producers to find other devices to achieve the same end. By 1938, when the Ottawa Agreement was due for revision, scarcely a primary producer faced the future with confidence. The Anglo-American trade talks carried suggestions that the objectionable preferences of Ottawa should be whittled down. The British representative at the Empire Producers' Conference at Sydney in March 1938 declared that the British market was nearer saturation point than was realized, and that, if Australian producers did not act to regulate exports, the British government would. The Australian 'trade diversion' policy of 1937, the difficulties encountered in the Anglo-Australian trade talks of 1938, and the postponement of a renewal of the Ottawa Agreements were the main developments prior to the outbreak of World War II.

Economic Policies During World War II

After 1939, the central policy governing production and trade in most countries, and the character of world trade as a whole, concerned the maintenance of supplies for waging the war. The diversion of resources to war purposes, and the allocation of supplies to military and civilian needs, affected every national economy and every commodity and service. The techniques of the 'fortress economy' were relentlessly applied; where necessary, production was stimulated by means of price mechanisms under national service regulations; labour, raw materials and foodstuffs were allotted to essential needs and strategic stocks were built up for continuity of supplies; government controls were extended to every activity and reward; controls over credit, prices, wages, and capital investment were tightly organized country by country. International co-operation of a new and far-reaching kind decreed world prices, the movement of shipping, and the relationships of the various currencies of the United Nations. Regulation of rural production, on the one hand, accompanied the expansion of manufacturing industries, on the other. For the warring groups of nations, resolute policies of maximizing the war effort completely eliminated free trade and altered the whole pattern of rural and manufacturing activity throughout the world. Self-sufficiency was established upon a new basis of belligerent grouping.

Post-War Economic Problems

During World War II the problems of defining war aims, of overriding restrictive trading practices, and of agreeing upon plans for reconstruction had to be faced by the United Nations. Following high-pressure discussions, the Atlantic Charter (1941) and the Mutual Aid Agreement (1942) were drafted and formed the basis of the conference upon economic rehabilitation at Bretton Woods (1945). Broadly stated, the objectives of this conference were focused upon raising standards of living throughout the world by providing high and stable purchasing power by means of high employment and free access to the world's resources. As methods of realizing these aims, monetary policy was to be directed towards the re-establishment of national currencies and exchange rates, and towards stabilization of world prices, in the first place, and towards the removal of hindrances to freer trade, in the second. A preparatory conference, called in London in 1946, examined the problems involved in the displacement of economic nationalism by more liberal trading relations and in drafting a charter for an International Trade Organization. This draft was considered in 1947 at the Geneva Conference, and all the difficulties involved in reduction of tariffs, modification of traditional trade practices, and elimination of discriminatory trade systems were at once apparent. Ratification was required of the recommendations drafted at Bretton Woods to set up the World Bank and World Monetary Fund for the purpose of assisting the rehabilitation of war-torn countries, and of preventing a chronically adverse balance of payments in any country from leading to currency depreciation. After much difficult negotiation, agreement was reached upon some of the big controversial issues in October 1947, about which some further explanation is now necessary.

Imperial Preference and the Geneva Conference, 1947

At Geneva the whole anatomy of preferential trade among the countries of the British Commonwealth was placed upon the dissecting table.[8] The tie that binds both Britain and the Empire countries firmly within the imperial economic system is the capital investment of the past. Australia's strength and weakness is £550 millions stg. of overseas debt upon which interest must be paid in the form of exports. So long as the obligation is acknowledged, Australia must export, and Britain will be unwilling to take any steps which will make the payment of interest in Australian exports more difficult. The essential compromise is, therefore, to balance willingness to pay with capacity to receive.

The problem, however, can scarcely be stated in such simple terms. British farmers, stimulated by government policy to produce more, both as a measure of wartime sufficiency and as a means of employment, demand a regulated price level in their home market; and, for that reason, Britain's

8. See *Report of the First Session of the Preparatory Committee of the United Nations Conference on Trade and Employment*, Washington, 1946. Reprinted by Commonwealth Government, 1947.

capacity to absorb more overseas production in certain commodities will diminish to some extent. On the other hand, the expansion of settlement, the intensification of land use, and improvements in pastoral and agricultural techniques in Australia all tend to enlarge the output of primary products.

The 1947 Geneva Conference, at which it was hoped to set up the International Trade Organization, was the stage upon which American desires for free enterprise throughout the world came into conflict with the system of imperial preference. After prolonged discussion, a wide working agreement was reached upon tariff reduction; but despite this agreement it will prove very difficult to reconcile America's world policy of freer trade and Britain's plans for mobilizing British Commonweath resources by means of a preferential trade system for economic recovery. Deep-seated differences in commercial policies persist.

The I.T.O. Agreement comprises a multilateral trade treaty binding Britain and U.S.A. and twenty-one other countries to tariff reductions covering a great part of world trade. This agreement was signed on 30 October and published on 18 November 1947. It is, in President Truman's words, 'a landmark in the history of international economic relations,' and stands in very great contrast to the abortive 1933 World Economic Conference when the United States walked out on her world responsibilities. The important results hoped for are that co-operative action to make accessible to all nations world production and world productive resources, that currency management and trade development will be tied into a workable international system, and that reasonable stabilization of world prices will become possible. Those would be, for Australia, main factors in the land utilization problem.

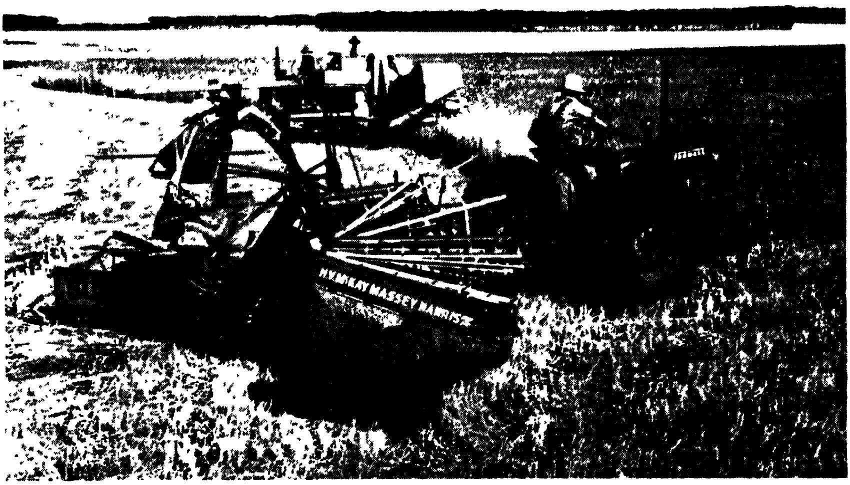
The facts of price movements for primary products in recent years are well known, and bear closely on the problem we are now discussing. They are shown in the Commonwealth Statistician's Index[9] of Australian *export prices*, excluding gold (average three years ended June 1939 = 1,000):

1936-37	1,115
1937-38	1,024
1938-39	821
1939-40	925
1940-41	1,026
1941-42	1,047
1942-43	1,137
1943-44	1,169
1944-45	1,304
1945-46	1,476
1946-47	2,131
1947 (July)	2,415

9. This weighted index is compiled from the prices of 20 commodities which constituted about 85 per cent of all Australian exports, and is published in the *Monthly Review of Business Statistics* (Commonwealth Bureau of Census and Statistics, Canberra).

(*Victorian Dept. of Agriculture*)

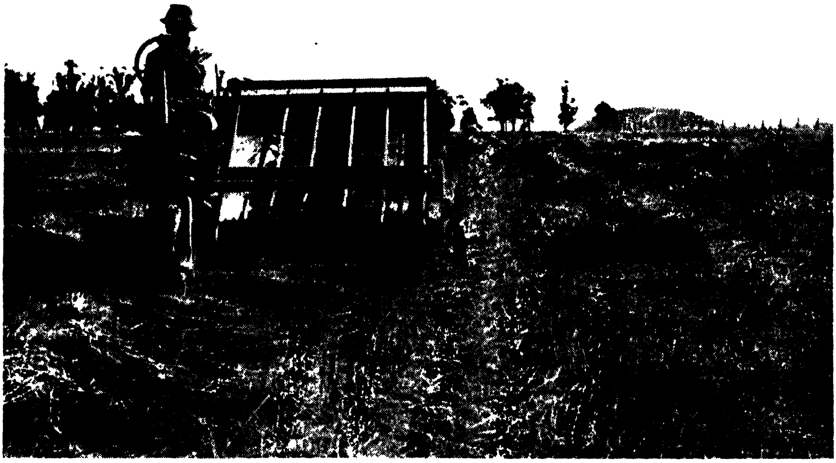
Plate 65. Tobacco on newly cleared land, Stockdale, Vic.



(*Dr. I. F. Phipps*)

Plate 66. 'Dual' harvesting of flax, Lismore, Vic.

The 'header' is in the background.



(*Dr. I. F. Phipps*)

Plate 67. Flax 'pick-up' machine in operation

After the retting is complete the flax straw is bound into sheaves by this machine and then carted to the flax mill.

(*Victorian Dept. of Agriculture*)

Plate 68. 'Direct' harvesting of blue peas, Tasmania

The crop is being mowed and 'picked up' in one operation.

(*Victorian Dept. of Agriculture*)

Plate 69. French beans, Dargo, Vic.

River flats in Gippsland grow the bulk of the Victorian bean crop.

(*S.M.W.*)

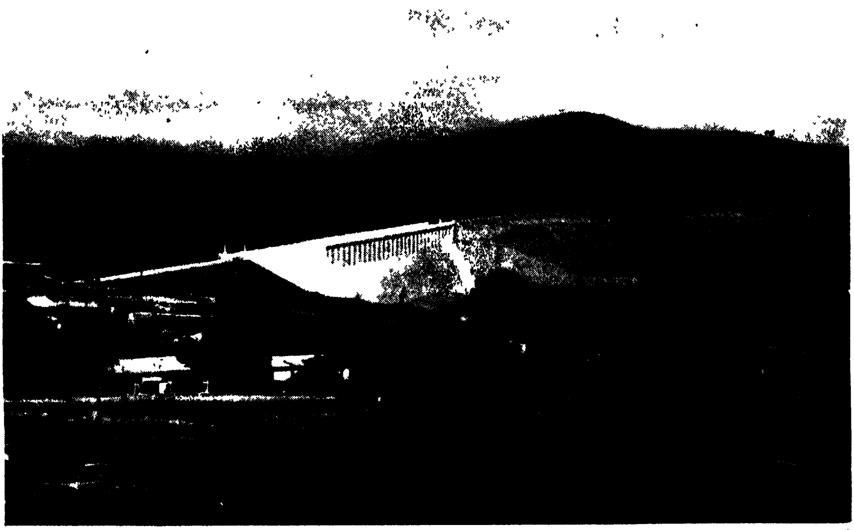
Plate 70. Bagged carrots ready for transport on the field, Tasmania

Small swamp areas in North-West Tasmania developed during World War II to produce carrots and other vegetables.

(S.M.W.)

Plate 71. Rock water catchment in the dry farming area of W.A.

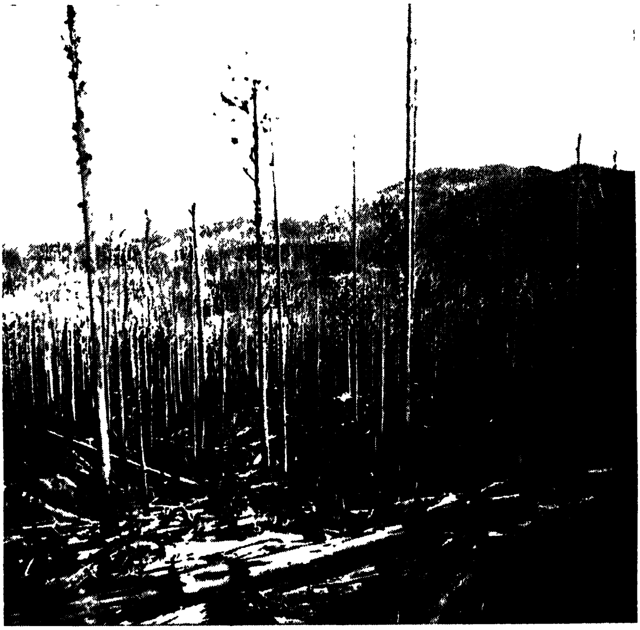
The bare granite surface shown on the right gives very good run off of water. The low wall of concrete and boulders run very close to the contour and divert the water to a small reservoir.



(*Victorian Railways*)

Plate 72. Hume Reservoir on the Murray River

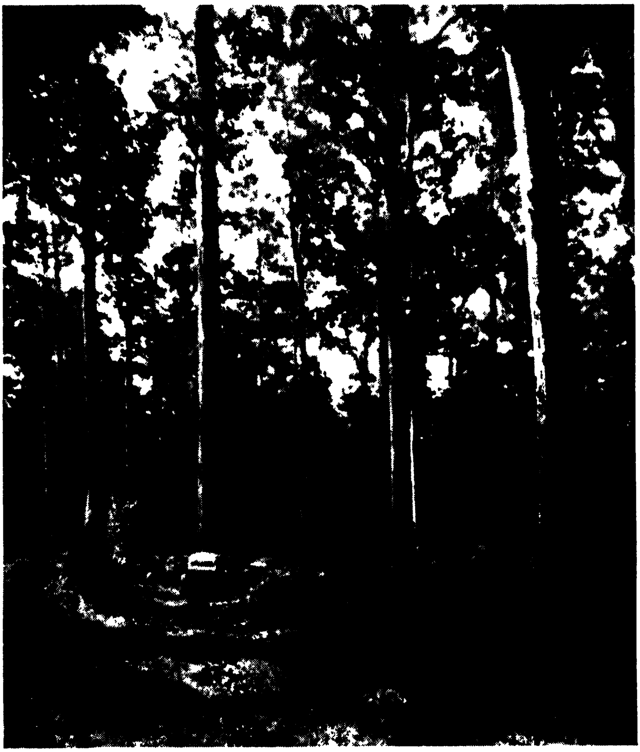
The largest water storage in Australia. It has a water holding capacity of 1,250,000 acre ft.



(*T. W. Hogan*)

Plate 73. Burnt forest of Mountain Ash at Tanjil Bren, Vic.

Some of this burnt timber was utilized during World War II.



(*S.M.W.*)

Plate 74. Forest track in the Karri areas of W.A.

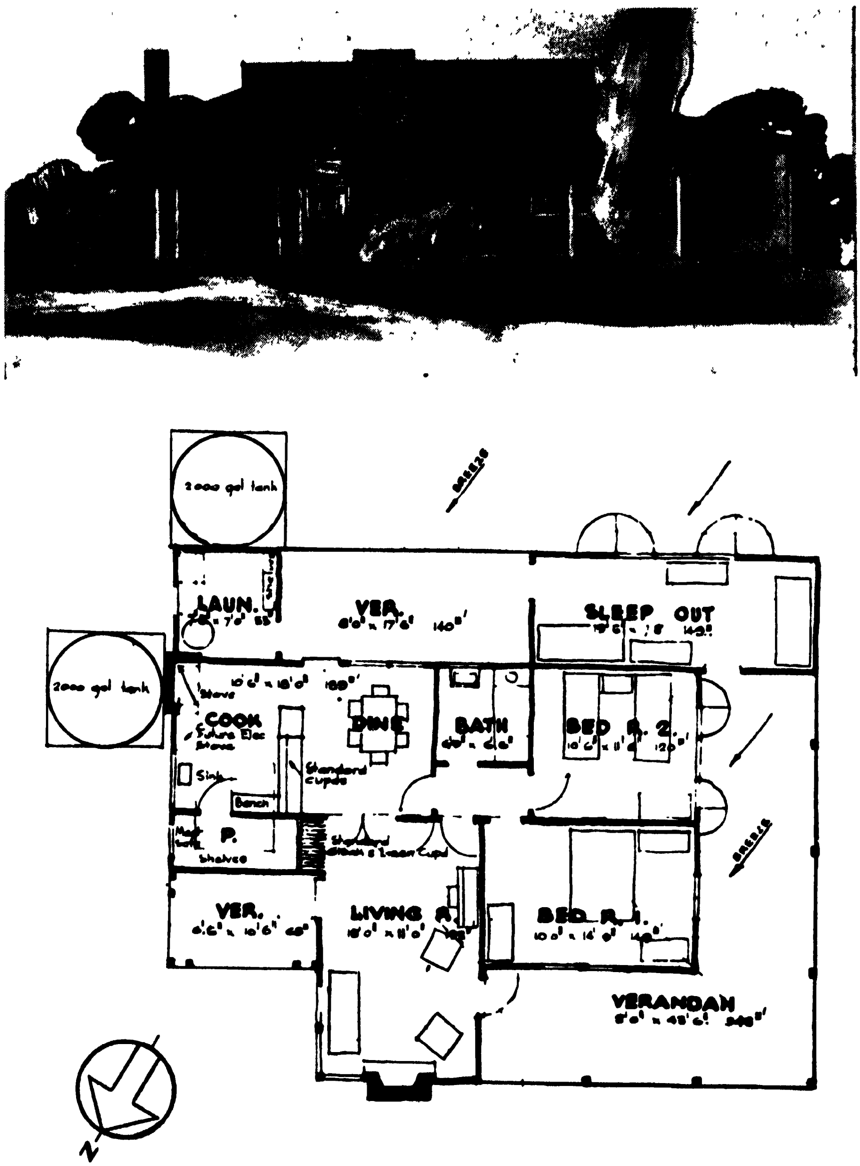
Karri and Jarrah are the principal hardwoods of W.A. They have proved suitable for a wide range of uses for which softwoods are considered necessary in the other states.

(C.S.I.R.)

Plate 75. Immature stand of naturally regenerated Cypress Pine, Qld.

('Pix' Photo)

Plate 76. Logs for the newsprint mills from Fitzgerald, Tas.



(*Soldier Settlement Commission, Vic.*)

Plate 77. Architect's drawing and plan of a house being erected for soldier settlement in Victoria

This represents a rise of 109 per cent. However, allowing for relative *quantities* of commodities, including gold, actually sold at the different ruling prices during each month, the 'changing weights' index rose from 1,040 in July 1945, to 1,473 in July 1947, i.e., a rise of 42 per cent. The *import price index*, published by the Commonwealth Bank, rose from 100 in 1938 to 232 in July 1947, a rise of 132 per cent, but a changing weights index for import prices is not available.

Taken in conjunction with these movements, the facts of the Anglo-Australian trade position should be noticed at this point. British exports to Australia in 1937 represented 7·2 per cent of the total value of exports, while Australian imports into Britain were 7 per cent of total imports. The percentage table given below shows that for wool, wheat, and dried fruits Australia has a wide market, but that for meat, butter, fresh fruit, sugar, eggs and wine the market is almost entirely limited to the United Kingdom.

United Kingdom Market and Australian Exports

Commodity	Imports from Australia as percentage of total imports into U K. (approx.)		Exports to United Kingdom as percentage of total Australian exports (approx.)	
	1937	1946	1937	1946
Wool	39	48	37	19 (b)
Wheat	22	(a)	61	(a)
Butter	16	31	92	92
Beef	14	12	99	72 (c)
Mutton and Lamb	28	12	98	95
Pig Meat	3	5	98	87
Dried Fruits	39	25	58	62
Fresh Fruit	27	20	87	48 (d)
Eggs	5	18	99	96
Sugar	17 5	1	98	10
Wine	—	19	95	74 (e)

(a) None shipped to U.K. To conserve shipping space Britain drew wheat from North America and Australian wheat was shipped to countries in S. Asia, for which the U.K. was responsible for procurement. (b) Good stocks in U.K. Europe and U.S.A. bought heavily. (c) Supplies diverted to British service areas. (d) Shortage of shipping space. (e) Annual quota scheme.

Source: Commonwealth Statistician and Imperial Economic Committee.

From this discussion it would seem that the solution of Anglo-Australian trade problems for certain commodities can no longer be sought on a bilateral basis. Both Britain and Australia have trade and financial connections extending beyond the Empire, and it is in the interests of both countries to strengthen these. An increased export trade with many countries must mean, in the normal course of events, increased imports from those countries. The ultimate pattern of trade for most countries will be decided by the resultant economic advantages, i.e., by efficiency in production. Australian producers are facing

the hard fact that lowering costs in terms of international currency is the way to efficiency, and that expansion of Australian exports cannot be advanced indefinitely by schemes for raising domestic prices.

The following table of percentages of the value of total Australian exports taken by various countries since 1925-26 will indicate the changes which have occurred in overseas trade.

Destination of Australian Exports

Percentage of the Value of Total Exports to Selected Countries (Excluding Gold Bullion, Specie and in Matte)

Importing Country	1925-26	1930-31	1938-39	1946-47
United Kingdom	41·43	44·02	48·90	28·45
Other British (inc. India)	11·35	11·08	13·09	26·35
Belgium	4·16	0·66	3·95	6·19
France	12·49	7·50	6·68	6·73
Germany	4·70	5·90	1·89	0·45
Italy	3·13	3·88	0·86	4·41
Japan	7·43	10·56	3·46	1·81
Netherlands East Indies	0·73	0·43	0·98	0·16
U.S.A.	8·73	3·25	13·92	15·52
China	0·49	3·27	2·15	1·97
Other Foreign	5·36	9·45	4·12	7·96

Source: *Commonwealth Year Books.*

Other trends which have the opposite effect are a consequence of the altered circumstances of certain countries which were previously vigorous competitors in the British market. The difficulties of post-war economic and political adjustments, the impact of world-wide inflation with its differential effects on prices and costs, the wide differences in levels of national prosperity, the differing intensity of incentives to produce in all countries, and the certainty that competition in world trade will become more acute than ever before, all make prediction unwise if not foolhardy. Looking more particularly at the U.K.-Australia economic and financial system, the effect of these tendencies should be to increase opportunities to expand Australian trade with Britain; but, for a time at least, a dominant factor will be Britain's capacity to pay for imports in the manufactures Australia requires, especially if the terms of trade continue to move against her.

Markets and Land Use

We must now return to the main theme. To summarize: the limitation of markets, particularly when accompanied by methods of price stabilization by means of producer control, or of cost stabilization by means of tariffs, will tend to have a retarding effect upon both extension and intensification of land use. The margins for expansion of Australian trade in either the

home market or in overseas markets are obviously quite narrow, despite the demands of those markets during World War II and since the war ended. The possibility that the British market may in the long run absorb less of Australian exports has directed attention to the possibility either of expanding the Australian market or of entering world markets other than British. That there are limits to the expansion of the home market in Australia under present policies and trends needs little elaboration. The absolute numbers of the Australian population increase slowly, and the present surplus production would, for certain principal commodities, suffice for a large addition to present numbers.

The possibility that world collaboration for raising the standards of living in all countries may result in an enlarged demand for the higher grades of foodstuffs should be considered. The International Labour Conference and the League of Nations took the initiative in drawing attention to the need for a practical survey of the actual level of nutrition of the workers in various countries.[10] The futility of pre-war conditions under which, although wholesale starvation was no longer common, malnutrition and its attendant mental and physical disabilities were frequent, requires little comment. The fact that the maladjustment of the world system had led to the restriction of production or even to the destruction of produce on the one hand, and the grim spectacle of millions whose diet was often deficient in meat, fruit and fat, on the other, was a deplorable feature of world economic disorganization.

All these features of under-nutrition and malnutrition were intensified to an almost incredible degree during and after World War II in most countries of Europe and Asia. Destruction, scorched-earth policies, the effects of enemy occupation, displaced peoples, and widespread human degradation have now piled up into a colossal total of misery which calls for amelioration and rehabilitation on a vast scale, as the ministrations of the Red Cross organization, the activities of U.N.R.R.A., and, more recently, the investigations of F.A.O.,[11] have revealed. The awakening of an international consciousness on such matters has been rapid, and has led to action which may lower or remove the obstacles hampering international trade. Even in this event, however, the reduction of the costs of production will still remain a matter of great significance for impoverished consumers, but the prevailing world inflation is working adversely.

Expansion of home consumption in Australia even beyond that of present prosperity is possible. Nutrition is imperfect in Australia for large sections of the people. The Commonwealth government set up an Advisory Council, which carried out an investigation into nutrition in all capital cities and some

10. International Labour Office, *Studies and Reports*, Series B, No. 23, Workers' Nutrition and Social Policy, 1936. Also *Final Report of the Mixed Committee on the Relation of Nutrition to Health, Agriculture and Economic Policy*, L.N.O.P., A.13, 1937, IIA.

11. *World Food Survey*, Food and Agricultural Organization of U.N., Washington, 1946, and *Report of F.A.O. Preparatory Commission on World Food Proposals* (*ibid.*, 1947).

country districts of Australia. The results have shown that there is a considerable deficiency in the consumption of milk, while the larger families also tend to eat less vegetables, fruit, and butter than is desirable.[12]

Failing a very considerable addition to the numbers of the present population, or a marked rise in the standards of consumption in Britain, Europe or Australia, it is reasonably certain that, although production of certain commodities, e.g. mutton, could be expanded at present prices, little expansion of total production was warranted under pre-war price conditions. If prevailing prices for products from the land, especially for wool and foodstuffs, were likely to be maintained, there would be every justification for policies of expanding production and of extending settlement in under-developed areas. Unfortunately price visibility over the long term is very low, and the experience of such expansion under the influence of high prices after World War I was not happy. It is now a deterrent, for it would be idle to deny the uneasiness of Federal and state Treasuries about the final costs of ex-service settlement, or the anxiety of departments of trade and commerce to consolidate old markets and to establish new ones. The total result of the search for markets by all exporting countries will be in the direction of intensified trade competition when abnormal post-war demand subsides.

2. IMPROVEMENTS IN PRODUCTIVE EFFICIENCY

Conditions Affecting Employment on the Land

In common with other countries operating under an extensive system of primary production largely for export, alongside a system of expanding secondary production for home consumption, the distribution of population amongst industries in Australia has undergone marked changes in the last few decades. The most notable of these changes is spoken of loosely as the 'drift to the cities', still more loosely as 'rural depopulation', and very seldom with more accuracy as 'a rearrangement of labour and capital resources in response to modern techniques of production'. The 1947 census figures reveal that there has been a general decline since 1933 in the proportion of population in the rural areas of Australia. The population living in urban and rural areas, respectively, is shown below.

	1921		1933		1947	
	Millions	%	Millions	%	Millions	%
Metropolitan .	2·4	43·01	3·0	46·87	3·9	50·72
Rural	2·1	37·35	2·4	35·91	2·4	31·31
Provincial urban	1·0	19·09	1·2	17·22	1·4	17·97

12. *Final Report of Advisory Council on Nutrition*, 1938, pp. 34-5 (Govt. Printer, Canberra).

Allan B. Fisher[13] holds that this kind of rearrangement of labour resources is due to several powerful influences which have affected primary, secondary and tertiary industries profoundly in the last fifty years or so. The increasing use of power machinery in farm operations diminishes the opportunities for employment of human labour on the land, whilst industrial urbanization based on rural industries tends to concentrate population in the metropolitan areas at the expense of the small country town. Also, the improvement and cheapening of motor vehicles, and the building of modern high-speed roads naturally converging on the large industrial centres, have constituted another powerful influence making for concentration rather than dispersion of population. The diminished proportion of the people living and working on or near the land has been compensated by the increased proportion of people working in secondary industries or in distributive trades. This merely means that many operations that were formerly done in local workshops are now carried out more efficiently in large-scale factories under mass-production conditions, and that potential primary producers have become operatives or distributors. Wherever machinery can be used or power applied to rural operations, these tendencies are maintained. The displacement of rural workers by machinery has shown its maximum effect in agriculture, but, to some extent, the process has extended to shearing, to dairying, to clearing, and other rural occupations.

The Trend to Intensified Land Use

Urbanization is regarded, uncritically for the greater part, as an undesirable or indeed dangerous tendency. The whole trend of agricultural policy and rural development in Australia has been in the direction of breaking up the large estates, and of promoting schemes loosely labelled 'closer settlement'. In all states it has been felt for a long time that more farmers, and intensified land use, were necessary for sound national development, without any appreciation of the greater knowledge required for effective land use of an intensive kind. After the war of 1914-18, the repatriation of large numbers of men who had spent up to four years leading an out-of-doors life reinforced a vague sentiment by the necessity for finding openings for them in civil life. A new pressure, represented by a national desire to reward returned soldiers, was added to the old 'back-to-the-land' idea. Settlement schemes were hurriedly prepared in all states, and the penalty of haste was waste, both of capital and of effort. In general, however, soldier settlement served to enlarge the boundaries of productive areas. The task of increasing exports was not very difficult during the 1924-29 world inflation, and, in any case, there was little difficulty in inducing Britain to make room in her markets for the products of the men who had helped

13. Fisher, A. B., 'The Drift to the Towns,' *Economic Record*, Nov. 1929. See also this author's *Clash of Progress and Security*, chap. III (Macmillan).

to defend the interests of Empire. The Empire Marketing Board and the 'Buy British' movement in England were, in fact, complementary to soldier settlement, and also stimulated migration to the Dominions.

After World War II, a more scientific attack upon the problems of ex-service settlement was planned under the aegis of the Department of Post-War Reconstruction. Co-ordination of Commonwealth and state government efforts, from the provision of finance to the approval of land acquisition and the extension of rural amenities, was agreed upon. Land settlement authorities were set up in each state to administer these plans, which are now in the course of execution.

In sober truth, costs of establishment have always been so high in Australia and distance from Europe so great that they explain the unattractiveness of the country for migrants during the years in which they were pouring out of Europe. Except during the gold rush of 1850-60, the nearness of North America to Britain made it difficult for Australia to secure more than a small proportion of emigrants from Great Britain and Europe. In the three decades between 1860 and 1890, the rate of absorption of migrants for each period was 12, 10, and 14 per thousand of population respectively—a trifling increment compared with that of Canada or the United States. In the depressed 'nineties, the rate of absorption fell to less than one per thousand, but rose to that rate for the decade ending 1910, and to four per 1,000 for the decade ending 1920. For the forty-five years from 1890 to 1935 the total increase of population was 3,602,000, of which only a total of 575,000, or about 16 per cent, was due to net immigration. For the post-depression years the inflow of intending settlers was small, partly as a result of the decline in European population, partly because of disturbed economic and political conditions, partly because of difficulties of obtaining capital, and partly owing to ill-founded and narrow national prejudices against migrants in general. The increase in Australian population between 1933 and 1947 has been mainly the result of the excess of births over deaths.

3. THE EFFECTS OF ECONOMIC POLICIES UPON LAND USE

The difficulties of obtaining capital for settlement are of two kinds. Primary industries and primary producing countries were not as attractive after 1900 for investment as they were in the nineteenth century, mainly because of the fall in prices for primary as compared with secondary products. Capital for land settlement came mainly from public rather than from private sources. Most of the state governments were unwilling to incur further indebtedness for the stimulation of migration. Public controversy indicated uneasiness concerning any relaxation of the immigration law requiring migrants to possess a certain amount of capital.

The states, however, have the responsibility for policies of rural development, and it is here that lack of co-ordination and the main incompatibility

between state and Federal policies were to be found. For the states with the highest proportion of marginal land, viz., Western Australia, South Australia and Tasmania, the clash of policies was so serious that financial assistance, by way of special grants from the Federal government, became necessary after 1920.

The effects upon land development and settlement of the different social, political and economic conditions after World War II, and the changes in policy which have resulted, are discussed in chapter XVII, and further discussion about these changes belongs there.

CHAPTER XVII

LAND UTILIZATION AND SETTLEMENT

1. The Limits of Expansion—General Considerations
2. Controlling Factors in Development Policy
3. The Costs of Equipment and Loan Losses
4. Amenities in the Country

Chapter XVII

LAND UTILIZATION AND SETTLEMENT

1. THE LIMITS OF EXPANSION—GENERAL CONSIDERATIONS

DISCUSSIONS about land settlement in Australia usually begin by focusing attention upon the disparity between the area of the continent and the population it now contains. The fact that an area of nearly 3,000,000 square miles contains about 7,500,000 people is accepted by most critics as *prima facie* evidence of under-population and under-development; but, whatever the possibilities or ultimate capacity of the country, the rate of absorption of new population in primary industries is strictly limited. The actual conditions of climate, topography and soil, which control settlement, have been examined with some care in the preceding pages, and the main conclusion which emerges deserves emphasis. It is that, whatever the standard of living accepted by the inhabitants, four-fifths of the country could not be settled much more densely because of rainfall deficiency or other factors. When the proportion of barren upland is deducted from the remaining twenty per cent which is *climatically* suitable for more intensive development, the disparity between people and area of land takes on an altogether different significance.

The conclusions as to the future development of land utilization which have been reached in the course of this research are less positive than may be desired, but they have an important bearing upon the general question of Australia's capacity to absorb population on the land. The conclusions reached, however, are confirmed by every reputable investigation made in the last two decades, and they may be set out as follows:

1. As regards the interior areas with low rainfall (less than ten inches annually in the south, and less than eighteen to twenty inches in the north), there are no reasons to expect any further development for agricultural purposes. On favourable soils there may be some increase in the amount of occasional cropping in conjunction with livestock industries, but there is no prospect of farming, in the accepted sense, being based upon such industries.

Unless care is taken, there is a very serious danger that land use in these dry areas may be retrogressive. Recent research suggests that stock-carrying capacity is tending to decline rather than rise, owing to deterioration in the forage. There is evidence, too, that the exploitation of bore water supplies will have to be regulated in the future. Soil erosion is already a serious menace in some areas, and will become more dangerous in the future unless the rate of stocking is controlled. The alternative courses for much of this

country are: (a) It might be exploited to the limit, which would convert much of it into virtual desert—a sequence which has been established for many other regions of the world; (b) it might be exploited cautiously, under the care of experts who understand the vegetation and its carrying capacity, and would be able to guard effectively against further deterioration. This would eliminate the danger of extending the desert, but might mean some reduction in monetary return. The present system is a mixture of these two types of land use. There is little prospect of a more intensive utilization of these areas.[1]

2. Irrigation projects have usually resulted in immense losses of capital which have been due partly to a failure to realize the need for a careful examination of soils before submitting them to irrigation, and partly to insufficient attention to the details of sound irrigation practice. The possibility of extending the existing irrigation areas is sharply limited by the small number of streams with reliable annual flow which have not yet been harnessed. Doubtless numerous schemes, large and small, will be developed in the future, but irrigation offers no solution to the problem of the vast desert and semi-desert areas. One essential is lacking—water.

3. As regard the regions of better rainfall (ten inches or more annually in the south, twenty inches or more annually in the north), exploitative use has proceeded rapidly in the past. An English expert comments:

'In the comparatively short time during which Australia has been developing her animal industries great progress has been made, and almost impossible things have been done in the clearing of bush country (which, for example, has not been necessary in other countries, such as the Argentine) and in fencing.'[2]

4. There are still millions of acres uncleared, but they are confined to regions in which one or more of the following factors operates:

(i) The forest is too dense to warrant the expenditure necessary for its removal and replacement by pastures or crops which could be grown effectively and economically. (Many other countries have large areas of native forest—Brazil, parts of south-east Asia, and Central Africa.)

(ii) The slopes are too steep for safe exploitation. Clearing has already progressed too far in some forest areas, and erosion by water is a menace wherever the moisture in the dry season is insufficient to allow the smaller plants and roots to hold the surface soil.

(iii) The soils are so poor that their value for extensive farming is too low to pay interest on the capital involved in their development. The light sandy areas of coastal districts, and the stony inland ridges with little

1. An excellent survey of the position in outback areas is to be found in the epilogue to *Flying Fox and Drifting Sand*, by F. N. Ratcliffe (Chatto & Windus).

2. Hammond, Dr. J., 'A Report on the Conditions of Animal Production in Australia,' *C.S.I.R. Pamphlet* No. 79.

surface soil are examples. As regards the former, scientific investigation has made the task easier during the last twenty years, but such soils will always require more careful and expensive treatment than those of higher natural fertility. Consequently, unless capital costs of development are very low, such areas will be vulnerable in periods of low prices for their products.

5. The transition from exploitative to intensive utilization has been taking place gradually for some time. The physical and climatic controls of this evolution limit the possibilities even in those parts of the continent which are worth developing. The operative factors should be noted:

(i) The discovery of new farming systems will enable farmers to achieve better control of their pastures and crops. The modern technique of wheat-growing in the grey chernozem-like soils of the Wimmera (cf. p. 168) is an excellent example of the extent to which the utilization of a district has been changed by the introduction of new methods. Pasture improvement technique is advancing rapidly in many districts.

(ii) Advances in farming methods are easier where soils are fertile than where they are intractable in texture or poor in nutrients. The lesson of land utilization in Britain is that the heavy clays can only be held under cultivation when high prices are obtained for the crops produced.

(iii) The capital cost of the transition from extensive to intensive utilization has proved an enormous burden upon the financial resources of a young country. Capital expenditure on railroad facilities for country districts with sparse populations has largely been made during the past seventy years. Road improvement on the grand scale began about 1927, and is still going on, thanks to the large sums of money becoming available through the tax on petrol. During the economic depression, the amenities of many country towns were improved by the development of water supply and sewerage schemes. Without these, the development of country centres as residential areas is unlikely, and some such development is essential for sound progress in agriculture.

(iv) On the farms themselves intensification depends partly on capital expenditure. In some areas this is relatively small, say £2 to £5 per acre (for fencing, water supply and equipment); but sometimes the costs are high. Whole areas are, at times, held up for lack of drainage during the wet season of the year. In these cases, co-operative action by farmers and governments is often necessary, and the work involved may require £5 to £30 per acre. Without this, intensive utilization is as impossible in Australia as it was found to be in Britain during the middle of last century.[3] In comparing agricultural systems in Australia and Great Britain with respect to productive efficiency, it

3. Scott Watson, J. A., and Elliot Hobbs, M., *Great Farmers* (Selwyn D. Blount).

must be remembered that the financial success of all capital improvements depends upon the margin between prices and working costs. If bankruptcy is to be avoided by the individual, or if heavy losses by the state are to be prevented, great caution is necessary when large expenditures are being made upon permanent improvements.

(v) The wide climatic fluctuations which occur in so many districts from year to year are an obstacle to the introduction of new methods. Farmers seldom think analytically, and a farmer may try a new procedure, which is successful for a year or two, and then, owing to the circumstances of the following season, his new method may give no better result than the old. He is naturally discouraged, and does not persist.

(vi) The proximity of intensive and extensive farms, which is so characteristic of many districts where soils are variable, or of any district during the primary phases of intensification, presents another difficulty. A progressive farmer may endeavour to improve his methods and cultivate species of plants which are novel to the district. These may be specially attractive to insect or other pests which are present, but of relatively minor importance in the adjacent paddocks farmed on the extensive plan. The result is an intensity of attack which would not have occurred if the whole district were being intensively farmed. The evil of rabbit attack on improved pastures is particularly widespread, but can be, and is, overcome by an additional expenditure on more elaborate fencing. There are many cases where the introduction of new farming systems is only retarded by difficulties of this type. Each is a problem in itself, and can only be overcome by careful scientific work.

(vii) In some specialized forms of production, development is held up by lack of adequate technical knowledge and equipment. While, at times, farmers themselves are able to initiate and develop new methods, such improvements depend on the assistance of scientific research workers in the majority of cases: the production of new varieties of plants, and elimination or control of pests, diseases or weeds, is usually impracticable without prolonged investigations, which are not successful without highly-trained direction. It required half a century of effort on the part of farmers, assisted by plant breeders, before the wheat industry found its correct environment and procedures under Australian conditions. It is reasonable to suppose that other crops, at present in a more or less experimental stage, will also require long periods before they become effectively established in Australia.[4] Examples of

4. Sauer, Carl, 'The Prospects for Redistribution of Population,' in *Limits of Land Settlement*, a compilation edited by Bowman, I. (Council on Foreign Relations, New York). 'The plant breeder is still extending somewhat the range of plant conquests, but the rate of progress is slow, and the emergence of "miracle" plants is likely to be of the order of frequency of miracles.'

such crops are tobacco, cotton and flax, and possibly soya-bean. To a considerable extent, the speed with which they attain efficiency will depend on the employment of well trained biologically minded research workers for the elucidation of the problems of each crop.

(viii) There is room for improvement in the meat and dairy industries, which, in their present form, still bear the marks of pioneer industries in their emphasis on volume of production on an extensive plan, rather than on efficiency and improvement of quality of the products. A considerable re-organization within each industry, and a re-allotment of territory between the industries, should form part of such developments, but can only take place with difficulty, owing to the small size of many holdings, and the reluctance of individuals to recognize and admit failure. The artificial aid given to the dairy industry through bounties and other aids tends to delay such redistribution.

(ix) The pre-eminence of wool in the economy of so many districts is a result of the relative ease with which sheep can be run under the climatic conditions which prevail over wide areas. The general level of efficiency attained by the wool-growing industry reinforces the hold which it has on the rural economy. To some extent, this has doubtless been a factor retarding the diversification of production in the districts of better rainfall. A prolonged fall in the price of wool on the world markets would have the effect of stimulating the development of mixed farming in some areas, particularly where pasture improvement and the storage of reserve fodders have become normal features of the industry.

(x) As intensification must, in the long run, depend on earning sufficient returns to recompense the capital outlay, and to allow for the depreciation which inevitably occurs, the movements of the price levels of the commodities produced dominate the whole process.

(xi) For fruit, cotton and some other minor crops, there is the possibility of a relatively large expansion, but these are commodities which were already over-produced in the world prior to 1939.

(xii) In 1948, and for a time at least, the high level of taxation and the difficulty of obtaining labour and materials are serious deterrents to enterprise and new developments, particularly where farmers are in a favourably stable position. Migration may help to solve the labour problem and the supply of capital goods will improve as time goes on, but farming incentives need sustained study by all authorities.

6. If the strict limits imposed upon settlement by the conditions set out above are admitted, the problem of closer settlement resolves itself into one of better utilization of that portion of the continent which is suitable for agriculture in the widest sense.[5] Better utilization means little more than

5. See *Australia: Its Resources and Development*, edited by Wood, G. L. (Macmillan, New York), 1947.

huge capital losses, sustained in the process of opening up new areas, or in trying to settle a larger population upon land already in use. Quite apart from the legacy of depression, these losses are, on the one hand, the penalty for over-optimism in the past, and, on the other, warnings of the unwisdom of allowing hope to triumph over experience.[8] Governments are now uncomfortably aware that the physical factors retarding development are potent, and when settlement projects concern areas that are definitely marginal, it is not to be wondered at that the attitude of governments is now more cautious. The settlement of ex-servicemen upon the land after World War I was a political necessity forced on by popular sentiment. It was mismanaged in many aspects, and severe losses upon state and Federal budgets ensued. More adequate selection of men, joined to scientific surveys of the areas before settlement, is the method of settlement after World War II. If the tempo of settlement is slower, it is at least less uncertain in its final contribution to the development of the country.

Land utilization in Australia has assumed additional significance since the redistribution of population became an international question. Occasional pronouncements in Great Britain and elsewhere regarding the capacity of Australia to absorb population have condemned the policy of the Commonwealth in severe terms. The people responsible for these statements have usually been distinguished by a total ignorance of the local conditions, if not by a perverse unwillingness to investigate the facts. The wide publicity given to irresponsible statements, compared with the restricted circulation of scientific studies, is a constant source of embarrassment. The fact that large areas remain relatively empty, not because of obstructive national policies, but because exploitation of the great bulk of the area is either climatically impossible or too expensive in human effort and capital, is disregarded. That rainfall is deficient and soils poor over wide areas, and that governmental hindrances to intensive land utilization are relatively insignificant, compared with natural restrictions, are facts that seem incomprehensible to many critics.

The main deterrents to settlement from the administrative standpoint are the 'costs of experiment', and the huge capital outlay involved in providing what Governor Gawler called 'the permanent equipment'. The need for considerable private capital as a pre-requisite to land-holding correspondingly retards pioneering from the settler's angle. Capital provision on a large scale is an indispensable accompaniment of settlement under Australian conditions; and, in the period 1850 to 1930, it led to a system of public borrowing which, in normal times, suited the economic regime of both the lending and borrow-

8. Sauer, Carl, 'The Prospect for Redistribution of Population,' in *Limits of Land Settlement*, a compilation edited by Bowman, I. (Council on Foreign Relations, New York). 'This greatest population movement sadly over-reached itself. . . . While men were prospecting land by trying what they could do with it, many of them settled on land that was unfit for the purposes of the settlement. A notorious illustration of this has been the invasion of the semi-arid Great Plains by grain farmers during recent periods of high prices.'

ing countries.[9] Expansion of markets and opportunities for investment and migration were the attractions to overseas investment, as far as the lending country was concerned, whilst high industrial activity, promoted by the introduction of new capital, made the system attractive to political parties, industrial interests, and investment houses in the borrowing countries.[10]

With the onset of world economic depression in 1930, however, an abrupt change occurred. Indebtedness was tremendously increased by the fall of export prices, governments could not avoid the responsibility of keeping insolvent primary producers on marginal lands, and the extent to which expansion had become uneconomic was disastrously revealed. To add to the difficulties, overseas loans abruptly stopped, and the demands of external creditors had to be faced. Under such circumstances, it is idle to attack the attempt on the part of a debtor country to maintain standards of living by means of tariff and monetary policy. If thorough overhaul of the whole theory upon which further settlement can proceed is now required, the inescapable physical and climatic controls need careful study.

The long-range control of settlement by investment received less than adequate consideration in the past. Its implications face the reader in every phase of the investigation conducted by the Canadian Pioneer Problems Committee.[11] It is the background of the declaration that 'Economic institutions that serve all regions, but are less available to the pioneer than to the mature community, are frequently the temporary or permanent controls determining the economic limits of settlement. Bank and credit institutions present the chief problems.' This is true of Australia as of Canada, of Argentine as of Siberia, and at bottom it is a problem of capital provision. The real economic costs of pioneering are summarized by one writer[12] in three questions which all have reference to the costs of capital:

1. To what extent is the pioneer community deficient in the services of these institutions? The problem of *services.*
2. To what extent does it pay more heavily for them? The problem of *discrimination.*
3. To what extent is the older part of the state taxed in order to provide those services to the scattered population of the fringe? The problem of *subsidies.*

The economic problem arises, therefore, from the comparative disadvantages under which certain regions labour in regard to capitalization. Sub-marginal, in the settlement sense, is not a term which is limited solely

9. Mackintosh. W. A., and Joerg, W. L. G., ed., *Canadian Frontiers of Settlement,* Vol. IV, chap. I and II (Macmillan).

10. Wood, G. L., *Borrowing and Business in Australia* (O.U.P.).

11. Mackintosh, W. A., and Joerg, W. L. G., ed., *Canadian Frontiers of Settlement,* Vol. IV (Macmillan).

12. See article by Mackintosh, W. A., in *Pioneer Settlement* (special publication of Amer. Geog. Soc., No. 14, edited by Joerg, W. L. G.).

by conditions of soil and climate. In Australia, situation and the character of the vegetation which must be cleared in the process of pioneering are the deciding factors in the degree of capitalization involved. Specialized machinery may have reduced these costs, but the savings are largely offset by the costs of housing and other amenities. That other considerations of great importance are involved need not be emphasized, even though they must be dismissed briefly. The universal condition upon which pioneering proceeded in the past is indicated by the statement made concerning Canada that 'much of the sub-marginal land, if settled at all, is likely to be colonized only by those who will be content with a standard of living lower than that demanded by the average English-speaking settlers.'

The widespread depression of regional standards of living following on World War II will doubtless increase the willingness of people to move to other countries. While Australian governments recognize their responsibilities for accepting displaced persons and other migrants as rapidly as the country can absorb them and transport can be provided, some extension of rural industry will doubtless occur. Difficulties such as housing and other restraints did not affect migration after World War I but the total result of settlement plans proved disappointing.

The authors may, perhaps, be forgiven for a perverse inability to see in the expansion of settlement any operative factor more powerful than the profitability of rural industry as compared with secondary industry. They fail to see how settlement can be permanent unless the economic compensation for the sacrifices involved promises to be sufficient. Marginal land, in short, will be settled and held under settlement as industrial activity and the demand for primary products makes settlement worth while. And, in general, it is the prospective rather than the actual reward which determines the real rate of expansion.

Regarded from this angle, the relatively low standard of living inseparable from the conditions involved in opening up new country is the cost accepted by the pioneer for anticipating a rising need for primary products which may or may not be realized, at least during his tenure. He lives, as it were, in advance of the demands of the time for farm products, in the hope of securing cheaply a title to land which will eventually become valuable enough to justify his speculative adventure. As population increases, and standards of living rise, the demand for farm products and for farm land increases, and over a period, say a generation or two, the ultimate compensation for pioneering hardships is realized. This is the control which is responsible for the expansion of settlement. Over a long period outward pressure of population upon marginal lands is persistently at work converting precarious fringes of tentative settlement into zones of permanent habitation.

Over a century of settlement it is the secular trend which counts, and this trend becomes more or less definite when population maps of successive periods are compared, more or less steady when the stability of the settlers themselves is observed over a lifetime.

In total, settlement on the Australian plan must be regarded as a problem of national investment. The costs of error are too great, and the penalties paid by the community as a whole during the depression too heavy, to allow political expediency to dominate economic foresight, as they have done so often in the past.[13] A new and sounder plan of attack must be developed which will maintain a balance between investment in rural and non-rural industry. The resources to be exploited must be examined from the angle of both productivity and costs. Seasons, soils and sales form the trinity which must be studied and understood as the basis of either maintaining the present front or of planning advance for the future.

The system of land utilization which has emerged from a century of settlement must, in short, be regarded as a response to these three controls. They are more fundamental than the three requisites to successful settlement —men, money, and markets—nominated by the Rt. Hon. S. M. Bruce in 1926.

The more aggressive controls are economic, and in the problem of more intensive cultivation such factors as markets, prices and marketing costs become decisive. The problem is to determine, not only how much it will cost to produce each additional unit per acre, but also how much the presence of that extra unit on the market may depress the price obtainable for the whole output. More bushels per acre may be raised, more sheep per acre grazed, more pounds of butter-fat produced per cow, but at an alteration in the profit margin which may render the increase in output unprofitable. The great dynamic in land utilization is the margin between prices and costs, and to the extent that Australian land utilization continues to be dominated by external markets, the relation between world prices and domestic costs will continue to regulate the profitability of farm operations and the intensity of land utilization.

4. AMENITIES IN THE COUNTRY

If, then, the main development of farming must necessarily be based upon commercial agriculture, it is clear that the standard of living on the farms is important. In the modern world in which the equipment and conveniences of city life are continually brought before the individual in the country it is not likely that settlement which does not bring with it reasonable amenities will be successful for long. Half a century ago people were prepared to settle on the land in the hope that they would ultimately make

13. See Copland, D. B., and Shann, E. O. G., *The Crisis in Australian Finance* (Angus and Robertson); and Copland, D. B., *Australia in the World Crisis, 1929-33* (C.U.P.).

a good farm, and the alternative was dire poverty in the city. Nowadays the matter is not so simple because it seems clear that even if a depression should set in, the government of the day would be forced to avoid large-scale unemployment by the provision of public works. The majority of people would prefer employment on these, which would give them reasonable labour conditions and opportunities for amusement and social intercourse. This means that the standard of equipment of the average farm house and the attractiveness of the country centre have become important items in the agricultural structure and its development. During recent years these matters have received some attention,[14] and although knowledge is far from complete, the outlines of the picture are becoming clear.

As far as the towns are concerned, a detailed survey has been made in Victoria by Mr. and Mrs. McIntyre.[15] The problem is frequently one of inadequate water supply and lack of any local industries other than those of distribution, a lack which means an inability to hold a population of the size which is a first essential to well-developed social amenities. According to the 1933 census, there were in the whole of Australia only thirty-eight country towns with a population of over six thousand. If we assume that six thousand is the minimum order of size which can hope to support the overhead costs of maintaining well-developed community services, the problem becomes apparent. The governments of the states are endeavouring to decentralize industry wherever this is practicable, and this will presumably have its effect in time.

As far as the farms are concerned, sociological surveys have been made of the representative samples of the wheat farms of Victoria,[16] and of the dried fruits districts around Mildura.[17] These two surveys show rather different results. On the one hand, the wheat industry had had a long period of depressed prices; on the other, the dried fruits industry had been reasonably prosperous. The one survey dealt with scattered farms, usually averaging one to the square mile, and the other closely-packed irrigation holdings, usually with electricity supply, and abundant water from the irrigation channels. In the former the equipment for such primary operations as those of the kitchen and the bathroom were often of a very low order. In the latter equipment was by no means palatial, but the general standard was much better. It is doubtful how far it would prove practicable in the modern world to hold a rural population unless improvement in such regards can be made and maintained. In the other states, circumstances are no better, and in some cases where the water supply is extremely exiguous they are

14. 'Rural Amenities,' *Seventh Report of the Rural Reconstruction Commission,* 1945 (Govt. Printer, Canberra).

15. McIntyre, A. J. and J. J., *Country Towns of Victoria—A Social Survey* (M.U.P., 1944).

16. Holt, A. J., *Wheat Farms of Victoria—A Sociological Survey* (Melbourne University Agricultural School, 1946).

17. McIntyre, A. J., *Sunraysia—A Social Survey of a Dried Fruits Area* (M.U.P.).

much worse over large sections of the countryside. This general problem of the amenities of the farm life will probably assume increasing importance as the years go by. In a free country with a policy which aims at full employment, at least for each effective worker, it will not prove practicable to maintain a progressive agricultural community if the gap between standards of life on farms and those in the cities is too wide.

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